Biographical Sketch of the Author.

Dr. WILLIAM B. TOWLES.

William Beverley Towles.

William Beverley Towles was born in Fluvanna County, Virginia, March 7th, 1847. He was descended from a family well-known in Virginia annals, his grandfather being Major Oliver Towles of the war of 1812, and his great-grandfather Colonel Oliver Towles of Revolutionary fame. His father was Dr. W. B. Towles, who practised extensively in Fluvanna and Cumberland counties. Reared in that famous country society of "Old Virginia"—the best form of civilization the world has known,—the noble qualities so conspicuous in the man were nourished and strengthened in the boy, and he bore through life untarnished "the grand old name of gentleman."

The civil war began when he was fourteen years old. Even at this early age the martial spirit of his ancestors was aroused within him, and in 1863, unable to longer endure inactivity, he left home, without his father's knowledge, to enter the army. On account of his youth, he was drafted into a reserve corps, which however, saw active service on several occasions.

After Appomattox he returned to his father's home to find it destitute and in need of his services. The best years of his boyhood had been given to his country, so that the problem of education still confronted him. Difficulties to which a less vigorous soul would have succumbed, served but to stimulate his dauntless spirit, and he applied himself with enthusiasm to his task. Exhausted by the day's labor on the farm, he retired immediately after supper; at two o'clock in the morning the alarm clock awoke him, and from then until break of day he applied himself to his studies with incomparable diligence. "History and the Latin

Classics, Chemistry and Anatomy were swallowed in huge draughts." So well did he prepare himself that when he entered the Medical Department of the University of Virginia, in 1868, he already "knew his text-books by heart." In spite of a serious attack of typhoid fever, he obtained his degree in one year.

From 1869 to 1872 he practised medicine in Missouri, where he made many friends. In the latter year he returned to the University of Virginia, having accepted the position of Demonstrator of Anatomy, tendered him by Dr. John Staige Davis. This position he filled until 1885, when, after the death of the gifted Davis, he was made Professor of Anatomy and Materia Medica. In 1886 he was elected Professor of Anatomy at the University of Vermont. This elevated position gave greater scope to his talents, and at his death he was the most popular and effective teacher of Anatomy in America.

He died September 15th, 1893, a few hours after delivering the first lecture of the session. During the progress of this lecture he suddenly became aware of the approach of death, but with characteristic bravery, he finished the lecture, and then returned home, where he laid down, and calmly and quietly awaited the end. To one who knew and loved him well, the most prominent of his many noble qualities was devotion to duty—duty to his country, to his family, his friends, his students, and especially to the great University, whose prosperity he so ardently desired. Having once determined that it was his *duty* to do anything, no earthly power could restrain him from its performance. No matter what difficulties might lie in the way, no matter how great the sacrifice of personal comfort or the physical and mental suffering involved, he marched, often rough-shod, and always with an invincible determination, where duty called. This devotion to duty was the ruling motive of his life, and as he had lived, so he died at the post of duty.

Courage and candor were equally conspicuous in him. He had the highest sense of honor, and the utmost scorn for all that was low and dishonorable. A mean action on his part is not even conceivable.

He was a man of intense feelings, a good lover and a good hater. The friends he had—and they were a host—he bound to him by the strongest ties. Loyal to the very core, true through evil report as well as through good report, in adversity as well as prosperity, generous in the extreme, it was a great privilege to have his friendship. His manner, while he could be and often was very stern, was naturally genial and cordial, and his hospitality charming to experience, so free from the faintest tinge of affectation. He delighted to have his friends about him, to make and to receive sallies of wit and merry banter at times, or to discuss important subjects at others. His sense of humor was very keen, he dearly loved a good joke, and it made one happy to hear him laugh. While often apparently brusque, he had a warm heart, easily moved by the misfortunes of others, and many a poor man to-day mourns his death as that of his best friend. He was a powerful man in all respects; there was no weakness in him, and his strong character left its impress on all who came under its influence.

> "This earth that bears thee dead
> Bears not alive so stout a gentleman."

His mind was singularly active, always on the alert for knowledge, quick to apprehend, and tenacious of its grasp. What he saw, he saw distinctly; he had few doubts. His knowledge was great, well classified, and always ready for use.

But his most distinctive mental faculty was a wonderful power of quick and accurate observation, and the mental pictures thus obtained were never forgotten. It is characteristic of him that while preparing himself for the study of medicine he memorized,

not the descriptions, but all the diagrams of a text-book of Anatomy.

He possessed great physical strength, and industry in proportion. So arduous was his self-imposed labor as Demonstrator of Anatomy that even his powerful frame was often exhausted to such an extent that he could not reach his home without resting by the wayside.

He was a born teacher, possessing in the highest degree the happy faculty of imparting his knowledge to others. His career made an epoch in the teaching of Anatomy in this country. His towering form and noble presence, his piercing eye, his intense enthusiasm, and the vivid and striking language in which his statements were made produced an impression never to be forgotten, and infused a vigorous interest into what is so often regarded as an uninteresting subject. He had, therefore, the orderly attention of his students, winning the admiration and respect of all, and the love of those who had the fortune to know him. His method of teaching was based on the fact that useful and abiding knowledge of Anatomy must be obtained by a practical familiarity with the structures themselves, and not from representations or descriptions of them. It was his boast that he made scarcely a single statement which was not demonstrated to each student individually. Every student was required to frequently dissect, and the principal truths were repeatedly demonstrated to him by a competent instructor; moreover he was required to verify these truths for himself over and over again, and to prove his thorough acquaintance with them by a series of practical examinations. Under such a system the eyes of the student were in constant demand storing up mental pictures, and there was no time for taking notes. It was therefore necessary for him to have some text-book containing accurate and concise statements of the facts of Anatomy which he could verify for himself on the cadaver. To meet this need Dr.

Towles had his "Notes on Anatomy," which he had prepared while Demonstrator, lithographed, and copies of these were supplied to the students. These books, however, were so full of clerical mistakes that he determined to have the "Notes" printed, and in this form they are now introduced to the profession. Had he lived he would have elaborated it into a complete text-book worthy of his knowledge and reputation as an anatomist. As it is, the book can give no adequate conception of his ability as a teacher; it is but a "faint adumbration" of the lectures delivered by him. It still contains some errors, old inaccuracies of statement, of which he by no means approved, but which have been handed down to us from the ancients and are still retained by the authorities. Nevertheless the book as it now stands excels all others known to the writer in the accuracy, clearness, and conciseness with which the truths of Anatomy are stated, and will be of the greatest assistance to the student.

To Dr. W. G. Christian is due the credit of correcting the clerical errors, and the sections on Hernia, the Axilla, and the Female Generative organs have been supplied by him from notes which he took on the lectures delivered by Dr. Towles.

RICHARD H. WHITEHEAD.

UNIVERSITY OF NORTH CAROLINA,
November 15th, 1893.

NOTES ON ANATOMY.

BY

WM. B. TOWLES, M. D.,

PROFESSOR OF ANATOMY AND MATERIA MEDICA IN THE UNIVERSITY OF VIRGINIA,

AND

PROFESSOR OF ANATOMY IN THE UNIVERSITY OF VERMONT.

ANDERSON BROS., PUBLISHERS,
UNIVERSITY OF VIRGINIA.
1893.

NOTES ON ANATOMY.

OSTEOLOGY.

The study of the bones which go to form the human skeleton, individually and in relation to one another, with regard to the appearances which they present to the unaided eye, and the uses for which they are intended, constitutes Osteology, as pertaining to Descriptive Anatomy. The chief uses of bones in the living body are: 1st. To give support to the softer tissues. 2d. To form receptacles for important organs. 3d. To form unyielding points of attachment for the muscles. 4th. To serve as levers, through which muscular action may be utilized.

In order to fulfill these functions, bones present many different points for study. They may be divided in a general way into: 1st. Long Bones, when the extension in one direction greatly exceeds that in the others. 2d. Flat Bones, when the extension in two directions greatly exceeds that in the other. 3d. Irregular Bones, when the preceding distinctions do not exist. In the study of a bone, notice: 1st. Its position and relation to other bones. 2d. The class to which it belongs. 3d. Give a description of the appearances on the bone: whether there be surfaces, borders, extremities, shaft, depressions or elevations, and especially note any articular surfaces, that is a surface produced by contact with another bone. In this connection it is proper to explain certain technicalities of frequent use—Internal and External—these terms should be used with reference to the middle line or plane of the body, that is one object is internal to another because it is nearer the middle line. They are often used incorrectly with reference to a cavity; interior and exterior are the terms to be here employed.

The bones are divided into those of the vertebral column; of the Thorax; of the Upper Extremity; of the Lower Extremity; of the skull; the Os Hyoides; the Ossicula Auditus.

The Vertebral Column.

The vertebral column, or spine, consists of a series of separate bones, classed as irregular, called vertebræ, and extends from the base of the

skull to the lower termination of the pelvis. It is flexuous in direction and of unequal size at different places, smallest in the neck, it gradually enlarges to below its middle and then suddenly tapers to a point. It transmits the weight of the head to the lower extremities, giving support on each side to the bones which enclose the thoracic cavity, and indirectly to those of the upper extremities, towards its lower termination it has expanding from it on either side the bones which form the pelvis. It forms the receptacle for the spinal marrow and its envelopes. In the adult it consists of twenty-six pieces, called vertebræ, which are divided into four classes; in the neck they are called cervical vertebræ, and are seven in number:

In the Thoracic region—Dorsal—twelve in number.
In the Abdominal region—Lumbar—five in number.
In the Pelvic region—Pelvic—two in number.

The last are known as sacrum and coccyx, and before adult life are composed of nine pieces—the sacrum having five and the coccyx four. The vertebræ of the different regions have characteristics which distinguish them from those of other regions, and each vertebra certain less noticeable ones which designate its position in its own region. Each region, however, possesses one or more bones so widely different from the typical vertebra of that region as to deserve the appellation of "Peculiar."

Since there are appearances common to the vertebræ of all regions, these must be first noted.

Vertebra.

Each vertebra consists of the following parts: 1st, Body; 2d, Foramen for the spinal cord; 3d, Laminæ (2); 4th, Pedicles (2); 5th, Spinous Process; 6th, Transverse Processes (2); 7th, Articular Processes (4); 8th, Intervertebral Notches (4).

1st. The Body is the front, thick, massive portion of the bone, flattened above and below to articulate with adjoining bones, indirectly, by the intervention of cartilage; it is more or less circular in outline and slightly flattened behind; the edges project somewhat in front and laterally, so as to produce a furrow on the front; its posterior aspect forms the anterior boundary of the spinal foramen.

2d. The Spinal Foramen lies between the body in front and the spinous process behind, and is bounded laterally by the laminæ. It is a large opening, varying in form and size in the different regions.

3d. The Lamina springs, one each side, from the postero-lateral aspect of the body, through the medium of the pedicle, and arches back to meet its fellow to form the spinous process, thus enclosing the spinal

foramen. It is flattened from side to side, and presents an upper and a lower border.

4th. The Pedicle is the more or less rounded commencement of the lamina.

5th. The Spinous Process juts backward from the union of the two laminæ.

6th. The Transverse Process projects laterally from near the anterior extremity of the lamina on either side.

7th. The Articular Processes are four, two superior and two inferior. They extend upward and downward from the lamina.

8th. The Intervertebral Notches are four, two superior and two inferior; they are furrows on the upper and lower aspects of the pedicles.

Cervical Vertebra.

The discrimination of a Cervical Vertebra involves the following points: it is the smallest; its body is smallest, having its transverse diameter greater than the antero-posterior; on its upper aspect the lateral edges are raised into ridges. The spinal foramen is largest and is triangular. The lamina is narrow and long. The spinous process is triangular and bifid at the extremity, generally. The transverse process is perforated at its base by an opening called the vertebral foramen, is grooved above and bifid at its extremity, forming two nodules which are called the anterior and posterior tubercles of the transverse processes. The Articular processes are oblique; the superior face upward, outward and backward, the inferior downward, forward and inward.

SUMMARY.

Body small—Transverse diameter greatest—Ridged laterally, above. Foramen large and triangular. Lamina slender, long, horizontal. Spinous process, triangular, bifid, horizontal. Transverse process, perforated, furrowed, forked. Articular process, oblique—Superior face upward, outward and backward; inferior, downward, forward and inward.

Dorsal Vertebra.

To discriminate a typical Dorsal Vertebra the following appearances must be noted:

The body is intermediate in size between that of a cervical and lumbar vertebra; there is no great preponderance of the one diameter over the other; although in the upper part of the region the transverse is slightly greater, and in the middle portion the antero-posterior. The most characteristic feature is the appearance, on the postero-lateral aspect, of the

body articular half-facets, situated, two on each side, at the upper and lower borders; these are for the reception of the heads of the ribs. The spinal foramen is smaller than in the other regions, and is nearly round. The lamina is short, slopes obliquely from behind, upward and forward, and is almost entirely covered by the origin of the processes which spring from it. The pedicle is deeply notched inferiorly. The spinous process is triangular, and is distinguished from that of a cervical vertebra by not being bifid, it extends downward and slightly backward. The transverse process is peculiarly well marked, being large, long and extending outward and backward, increasing in size as it removes from its origin so as to present an enlargement at its termination; that is, it is "clubbed." It bears on its anterior face, near its termination, an articular facet. The superior articular processes are vertical and look from each other, outward and backward; the inferior are opposite.

SUMMARY.

Body, no preponderating diameter; size, medium; Postero laterally has demi facets; Foramen, small and rounded. Lamina, short, oblique and covered by processes. Pedicle, deeply notched inferiorly. Spinous Process, triangular and not bifid. Transverse Process, large, clubbed—articular facet near end. Articular Process vertical—superior averted; inferior look towards each other.

Lumbar Vertebra.

The following is a description of a typical lumbar vertebra: The bone is altogether larger than those of other regions.

The body is larger, and is distinguished by two negative features: it lacks the lateral ridges on its upper surface, and the articular demi-facets on its postero-lateral aspect; the former discriminating it from a cervical and the latter from a dorsal vertebra. The spinal foramen is indistinctly triangular, and is intermediate in size, between the large cervical and the small dorsal foramen. The lamina is comparatively small, is horizontal, and presents no marked features. The spinous process is quite characteristic; its sides are quadrilateral in outline. The transverse process is long, and tends to a point, defined by the word "rib-like." The superior articular processes are vertical, and look towards each other, being farther apart than the inferior, owing to the fact that the inferior articular processes of one vertebra are received between the superior processes of the succeeding vertebra. The inferior articular processes are averted.

SUMMARY.

Body—large; no articular facet and no ridges above.
Foramen—obscurely triangular and of medium size.
Lamina—horizontal; Spinous process, quadrilateral.
Transverse process—pointed, rib-like.
Articular processes—Vertical—Superior face each other; inferior averted.

Peculiar Vertebræ.

The foregoing description of a vertebra in each region is, as stated, of one typical of that region; and this typical vertebra is one from about the centre of that region. Toward the confines of each region the vertebræ partake more or less of the characters of vertebræ in the adjoining regions, and so far depart from the type as to deserve the appellation "Peculiar"—thus demanding a special description. The departure from the typical vertebra is so great in some instances that the bones have received special names.

In the cervical region there are three peculiar vertebræ—the first, second and seventh.

The First Cervical Vertebra, or Atlas.

This vertebra is known as the Atlas because it supports the weight of the head; it resembles only in a slight degree a typical vertebra, having no body and being scarcely more than a ring of bone. It is described as consisting of four parts—two arches and two lateral masses—surrounding a spinal foramen of remarkable size—much larger than in any other vertebra.

The lateral masses stand one on each side, being connected before and behind by the anterior and posterior arch. The anterior arch is much shorter than the posterior, and forms one-fifth of the circumference of the bone; it presents on the centre of its front an elevation, called the anterior tubercle of the Atlas, and just behind this, on the posterior face of the anterior arch, is an articular facet for the odontoid process of the next vertebra. The posterior arch forms about two fifths of the circumference of the bone, and presents nothing worthy of note, except the posterior tubercle of the Atlas, found at the centre of the posterior face, representing the rudiment of a spinous process, and on each side just behind the lateral mass is, perhaps, a slight groove. Each lateral mass forms about one-fifth of the bone's circle, and sustains above and below the articular processes; the superior are characteristic of the upper aspect of the bone; each is an oval, oblique, articular pit, approaching

its fellow of the opposite side anteriorly. The direction of its obliquity is upward, forward, and inward; just behind this is seen the superior intervertebral notch, thus differing from other vertebræ, in which it is in front. The inferior articular processes are smaller, flat and round. The transverse process is flat and presents the perforation, but not the furrow above nor the forked end of other cervical vertebræ, on the inner face is a roughness.

SUMMARY.

Anterior Arch—one-fifth of bone; has on its front centre, anterior tubercle; on rear centre, articular facet for odontoid process.

Posterior Arch—two-fifths of bone—Posterior tubercle—Superior intervertebral notch.

Lateral Mass—one-fifth of bone—Articular processes, superior Concave, oval, oblique, articular; intervertebral notch behind it, inferior, flat and circular. Inner face rough.

Axis, or Second Cervical Vertebra.

This vertebra presents as its most distinguishing feature, a remarkable process called odontoid, (tooth-like), which springs upward from the superior aspect of the body and seems as though it were the body of the Atlas, separated from it and attached to the Axis. The process is constricted at its origin, the neck ; it next enlarges and finally tapers to a point, it presents in front just below its summit, an articular facet for the anterior arch of the Atlas, and opposite to this, on its posterior aspect, a smooth surface for the play of a ligament—the transverse; just below its top on each side is a prominent rough surface for the attachment of a ligament—the check.

The Body presents on its centre in front a vertical ridge and on either side of this a furrow; the upper surface is almost entirely occupied by the origin of the odontoid process, the inferior surface is oblique downward and forward. The spinal foramen is large; the laminæ bulky ; the transverse processes small, perforated and almost hidden by the articular processes. The spinous process is large. The superior articular process is flat and circular.

SUMMARY.

Body—ridge in front, furrow on each side ; inferior surface sloping downward and forward.

Foramen—large. Lamina—strong.

Spinous Process—massive.

Transverse Process—small and perforated.

Superior Articular—flat and circular.

Odontoid Process—constricted, then enlarged, then pointed; anterior and posterior articular facets and lateral roughness for ligaments.

Vertebra Prominens, or Seventh Cervical Vertebra.

The seventh cervical vertebra derives its sobriquet of prominens from its possession of a remarkably long spinous process, which distinguishes it from other cervical vertebræ.

Peculiar Dorsal Vertebræ.

The peculiar dorsal vertebræ are the first, ninth, tenth, eleventh and twelfth.

The *first* presents on each side of its body, above and postero-laterally, a whole facet for the head of a rib; below, in corresponding position, a half facet on each side. The *ninth* has but one demi-facet on each side, which is on the upper border. The *tenth* has one whole facet on each side. The *eleventh* has one whole facet on each side, but its transverse process has no articular facet. The *twelfth* has one whole facet on each side; its transverse process has no articular facet and its inferior articular processes are averted.

The Pelvic Vertebræ.

The pelvic vertebræ, specifically known as sacrum and coccyx, form the lower part of the vertebral column, and derive the appellation of pelvic from the fact that they form the posterior wall of the pelvis in the articulated skeleton. They are described separately.

Sacrum.

The sacrum lies between the fifth lumbar vertebra above and the coccyx below, and between the two ossa innominata. It is triangular in outline, its base being upward and its truncated apex below and backward and tipped by the coccyx. Its anterior face is concave, more so in men than in women, this being one means of distinguishing the sex to which the pelvis belonged. It is described as consisting of an anterior and posterior face, two lateral borders, a base and an apex.

The anterior face is concave and presents two vertical rows of foramina, of four each, one row on each side of the middle line, called the anterior sacral foramina; the upper two in each row, are considerably larger than the lower two. Connecting each foramen with the corresponding one in the opposite row is a ridge; these ridges marking the line of union of the five separate vertebræ of which the sacrum consisted

in the young subject. Passing outward from each foramen is a groove for a sacral nerve.

The posterior face is convex and narrower than the anterior. It is marked down its centre by a series of rough projections, constituting the sacral spine; these projections are the rudiments of spinous processes and grow smaller and at the lower part disappear, thus leaving exposed the lower opening of the sacral canal. External to the sacral spine, towards the lateral border on each side, is a row of foramina (of four each), called the posterior sacral foramina; these are smaller than the anterior: between each row of foramina and the sacral spine is observed a row of five tubercles, the rudiments of articular processes; external to each row of foramina is seen another row of tubercles, the rudiments of transverse processes.

The lateral border presents at its upper part a broad, rough, ear-shaped, or auricular surface, and behind this an exceedingly rough cavity; below, the border becomes thin and a rough edge.

The base, or superior border, presents in the centre a large oval surface, corresponding to the lower surface of the body of the fifth lumbar vertebra, with which it articulates. Extending outward on each side of this oval surface, is the portion of the base called the wing of the sacrum. Just behind the oval surface is the opening of the sacral canal, which is the continuation of the spinal canal from above downward through the sacrum. On each side of this opening is an articular process, in front of which, and to the side of the oval surface, is a groove called the inter vertebral notch.

The apex, or inferior extremity of the sacrum, presents an oval surface for articulation with the coccyx, and on each side of this a projection—articular process—called the cornu. Behind the oval surface is the opening of the sacral canal which terminates the spinal canal.

SUMMARY.

Anterior Face—concave—Four pairs foramina, connecting each pair a ridge, external to each foramen a groove.

Posterior Face—convex—sacral spine—five articular processes, four posterior sacral foramina, five transverse processes.

Lateral Border—auricular surface—rough cavity—rough edge.

Base—Oval articular surface—wings—intervertebral notches—sacral canal—articular processes.

Apex—Articular surface—cornu.

Coccyx.

The coccyx forms the lower extremity of the vertebral column; it originally consists of four pieces or vertebræ united, in the adult, into one bone, which is sometimes ossified to the sacrum. It is triangular in shape; its base is above, presenting an oval articular facet for the truncated apex of the sacrum; its apex is below and forward, the bone continuing the curve of the sacrum and frequently deviating to one side.

Vertebral Column as a Whole.

Upon casual observation the spinal column seems to increase in size from the second cervical vertebra to the sacrum, and then diminish suddenly to its termination; but upon close observation it is found, indeed, to increase in size from the first cervical to the first dorsal, but then it diminishes to the fourth dorsal, then increases again to the sacrum and again diminishes to its termination. The length of the column in the adult is from twenty-four to twenty-eight inches. It presents the following antero-posterior curvatures: In the neck it is convex forward, the first and second dorsal vertebræ partaking of this convexity; in the thoracic region it is concave forward; in the lumbar region it is again convex forward; in the pelvic region it is once more concave forward. When viewed from behind we see the projecting spinous processes, which in the cervical region are nearly horizontal, in the dorsal nearly vertically downward, and in the lumbar horizontal.

Sternum.

The sternum, or breast bone, forms the front centre of the thoracic wall, as the dorsal vertebræ form the rear centre; connecting these on each side are the ribs, which are prolonged by the costal cartilages. Extending outward from the upper end of the sternum on each side is the clavicle. So that the Thorax, or Chest, may be then bounded—in front by the sternum and seven costal cartilages; behind by the dorsal vertebræ, laterally by the ribs. The direction of the long axis of the sternum is downward and forward. Originally consisting of six parts, these in the adult become united into three—the upper or Manubrium, the middle, or Gladiolus, and the lower, or Ensiform, or Xiphoid cartilage. These are united by cartilage, but later in life may become ossified together, the ensiform cartilage frequently becoming ossified and firmly united to the gladiolus.

The Manubrium, or upper bone of the sternum, is the broadest part and is widest above. In its centre above is seen a depression called the

interclavicular notch; on each side of this is an articular surface for the clavicle, of concavo-convex shape; on each lateral border are seen one whole pit, for the reception of the cartilage of the first rib, and half the pit for the second, which falls at the junction of the Manubrium and Gladiolus.

The Gladiolus, or middle piece of the sternum, is the longest, is broadest in the centre and presents on each lateral border pits for the costal cartilages as follows, from above downward: a half pit for the second, four whole pits and a half pit for the seventh.

The Ensiform cartilage is the lowest piece of the sternum and presents many variations, sometimes bifid, or perforated, pointed or broad, or inclined laterally, forward, or backward. Laterally it carries above a half pit for the seventh rib. Considered as a whole, the sternum is convex anteriorly, and presents the transverse ridges, which become progressively indistinct below, marking the lines of union of its original constituents. When the Manubrium and Gladiolus are ossified together their union is marked by a very noticeable ridge, otherwise this place is marked, in the prepared bone, by a depression due to shrinkage of the uniting cartilage. The posterior surface is concave. The upper end is thick and broad and bears the interclavicular notch, with the articular surface for the clavicle on each side. Each side presents seven notches for the costal cartilages—the second falling at the junction of the Manubrium and Gladiolus, and the seventh at the junction of the Gladiolus and Ensiform cartilage.

SUMMARY.

Anterior Surface—convex, marked by ridges.

Posterior Surface—concave.

Lateral Border—seven pits for costal cartilages.

Upper End—interclavicular notch; two articular surfaces for clavicles.

Subdivisions—three:

(*a*) Manubrium, or upper piece; upper end broad; interclavicular notch; two articular surfaces for clavicles; one whole and one half pit for cartilages.

(*b*) Gladiolus, or middle piece; broadest in centre; sides present four whole and two half pits.

(*c*) Ensiform, or Xiphoid Cartilage—variable, either bifid, pointed or perforated, &c.; laterally a half pit.

The Ribs.

The ribs are twelve in number on each side, and are numbered from above downward, being usually divided into true and false. The true

ribs are the upper seven, and the false the lower five. The last two are called floating, since the cartilages, which merely tip them, are free. A better sub-division is into: 1st, the upper seven, vertebro-sternal; 2d, the next three, vertebro-costal; 3d, the last two, "vertebral."

The ribs curve around the sides of the thorax from the dorsal vertebræ, forming the sides and part of the back of that cavity; the vertebro-sternal stop short of the sternum, and are connected to it by means of cartilages; the vertebro-costal are connected, each by means of its cartilage, with the cartilage of the preceding rib; and the last two, as before stated, are merely tipped by cartilage, and are free.

The ribs increase in length from the first to the seventh and then decrease to the last; they decrease in width from the first to the last; they are broader anteriorly than posteriorly, except in the case of the last two.

In describing the ribs the appearances more or less common to them all will first be given, under the heading "A Rib," then the exceptions to this description will be noted.

A Rib.

A rib consists of two extremities, two surfaces and two borders.

The external surface is convex; the internal concave from before backwards; the upper border is thick and rounded; the lower, thin and sharp and marked by a groove on its inner surface. The posterior extremity terminates in a rounded articular surface called a head; this surface consists of two parts, separated by a horizontal ridge; the existence of this ridge being due to the fact that the rib articulates with two vertebræ, and the ridge is received between the two bodies. That portion of the rib supporting the head is called the neck, it presents a rough surface posteriorly and a ridge called the crest, on its upper aspect. The neck terminates anteriorly in a prominence called the tubercle, which is situated on the outer or posterior aspect of the rib, is generally rough, but presents at its base and inferiorly an articular surface corresponding to a similar one on the transverse process of a dorsal vertebra. The anterior extremity of a rib is thinner and broader than the posterior, and bears on its end a shallow pit for its cartilage.

Laying a rib, with its lower border downward, on a plane surface, it is observed to be twisted. On its outer surface near its tubercle is seen an oblique ridge, where its angle is located, and from this point backward the rib rises: this fact accounts for the ribs being oblique instead of horizontal when articulated.

SUMMARY.

The ribs are twelve on each side, numbered from above downward and classified thus: upper seven, vertebro-sternal; next three, vertebro-costal; last two, Vertebral.

External surface convex.

Internal surface concave.

Superior Border thick and rounded.

Inferior Border thin, sharp, grooved internally.

Posterior Extremity, Head—two articular surfaces separated by a horizontal ridge.

Neck—extends from head to tubercle; crest above and rough behind.

Tubercle—rough; articular facet beneath.

Angle and twist.

The variation from the foregoing description will be found in the following ribs:

The first rib is by far the most important; it is the broadest and shortest, is less oblique, has no angle or twist, presents one articular surface on the head—because it articulates with but one vertebra—and has its two surfaces looking upward and downward, and its two borders, external and internal. On its upper surface are two grooves, separated by a tubercle near the inner border with a ridge running from it forward and outward; the anterior groove is for the subclavian vein, and the posterior, which is deeper, is for the subclavian artery.

The second rib has on its outer surface near the middle a broad ridge.

The tenth, eleventh and twelfth ribs articulate with but one vertebra each, and have no ridge on the head.

The eleventh and twelfth have no tubercles and no groove on the lower border.

Costal Cartilages.

The costal cartilages correspond in number to the ribs, which they prolong anteriorly. They increase in length from the first to the seventh, then decrease to the last. In width they decrease from the first to the last. The first seven extend between the vertebro-sternal ribs and the side of the sternum; the next three connect the ends of the vertebro-costal ribs with one another, the last two are free. The first several are horizontal and those ensuing incline more and more upward, except the two last, which are horizontal.

The Skeleton of the Upper Extremity.

The skeleton of the upper extremity is divided into four segments, shoulder, arm, forearm, hand.

The skeleton of the shoulder consists of the clavicle and scapula.

The skeleton of the arm consists of the humerus.

The skeleton of the forearm consists of the radius and ulna.

The skeleton of the hand consists of the bones of the carpus, metacarpus and phalanges.

The Skeleton of the Shoulder—

The Clavicle.

The Clavicle, or collar bone, extends nearly horizontally outward from the upper end of the sternum, on each side, to the scapula. It may be divided into two extremities, two surfaces and two borders.

The inner extremity is the thicker, in fact the bone for some distance gradually enlarges towards the inner extremity. It is rounded, or triangular, bears on its extremity a concavo-convex articular surface for articulation with the manubrium, and generally another articular facet inferiorly to play on the first costal cartilage. The outer extremity is flattened from above downward, and presents at its tip a small articular facet for articulation, with the acromion process of the scapula.

The superior surface is rounded, convex and presents a roughness near the inner end.

The inferior surface presents a long shallow groove, terminated internally and externally by a process, the inner one called the rhomboid, the outer the conoid; extending outward and forward from this is a rough ridge, the trapezoid. The anterior border is convex for its inner, two-thirds, then concave; the posterior border is concave for its inner four-fifths, then convex. The clavicle is larger and more curved in a subject who has led a laborious life.

SUMMARY.

Inner Extremity—thick, rounded or triangular; two articular surfaces.

Outer Extremity—thin, flat, articular facet for acromion.

Superior Surface—rounded, convex; Tubercle internally.

Inferior Surface—grooved, conoid and rhomboid tubercles.

Anterior Border—convex for inner two-thirds; concave for outer one-third.

Posterior Border—concave for inner four-fifths; convex for outer one-fifth.

The Scapula.

The scapula or shoulder blade, is a flat, triangular bone, situated on the upper postero-lateral aspect of the chest, over the upper eight ribs, except the first. It consists of a body, having two surfaces, three angles, three borders, and of two processes. The anterior face, or venter, or sub-scapular fossa, is concave, has ridges running upward and outward, and presents a deeper depression towards its upper outer part called the subscapular angle.

The posterior face, or dorsum, is somewhat convex, presenting a prominent ridge, the spine, passing from the posterior border towards the head and dividing the dorsum into two unequal parts; the smaller, above the spine, called the supraspinous fossa; the three fold larger below, called the infraspinous fossa. The spine is triangular and presents three borders, two of which are free, one looking backward and the other forward and forming a smooth rounded edge which is continued into the acromion: around this the supra and infraspinous fossæ communicate. The third border is the attached one. The spine begins at the posterior border of the scapula, by a triangular smooth surface, and gradually rises to terminate in the acromion process.

The infraspinous fossa presents just beneath the spine a bulge, external to which is a deep, broad vertical groove; external to this a prominent vertical ridge; and external to this a smooth surface, widening as it descends towards the inferior angle, and, crossing this surface, an oblique ridge. The supraspinous fossa is concave, and about one-third the size of the infraspinous.

The superior border is thin and the shortest and deeply notched towards its outer end, this notch being called suprascapular. The anterior axillary, or inferior border, is thick and presents several grooves and, for about an inch above, a ridge. The posterior border, or base of the scapula, is the longest, and presents at the intersection of the spine a projection, the border retreating from this point both above and below.

The superior angle, situated at the junction of the superior and posterior borders, is about a right angle. The inferior angle, at the junction of the posterior and axillary borders, is acute and thick. The anterior angle is expanded and fashioned into a head, bearing on its extremity the glenoid cavity, which is a shallow, concave articular surface, oval in outline, smaller above than below, and having its long diameter vertical. Just behind, and supporting the glenoid cavity, is a constricted portion of the bone called the neck of the scapula. The processes of the scapula are two: acromion and coracoid. The coracoid springs from the bone

just above the glenoid cavity and projects upwards, and then turns and runs outwards and forwards.

The acromion is the outer termination of the spine, being flattened from above and behind downward and forward, it overhangs the glenoid cavity; it is convex above, concave below, and presents on its inner border about its middle an articular facet for the outer end of the clavicle.

SUMMARY.

Posterior Face—convex—supraspinous fossa—spine, which is triangular and presents three borders, two free—begins at post-border by smooth surface and gradually rises to terminate in the acromion. Infraspinous fossa—bulge, vertical groove and ridge, smooth surface, oblique ridge.

Anterior Face—venter, concave, sub scapular fossa, oblique ridges—sub-scapular angle.

Upper Border—shortest—thin—terminates in front in notch.

Anterior Border—axillary or lower, thick grooved, ridged.

Posterior Border—base—longest; angle at intersection of spine.

Superior Angle—a right angle.

Inferior Angle—acute, thick.

Anterior Angle—head, glenoid cavity, articular, shallow, concave, oval, long diameter vertical, large end below, Neck.

Acromion Process—convex above—concave below, oval, articular facet on inner border.

Coracoid—Overhangs glenoid cavity—projects forwards and inwards.

The Skeleton of the Arm—
Humerus.

The humerus forms the skeleton of the arm, extending from the shoulder to the elbow. Like other long bones, it may be divided into a shaft and two extremities.

The upper extremity presents the following appearances: Surmounting this extremity is the head, which is smooth, articular, forms somewhat less than half a sphere, and articulates with the glenoid cavity of the scapula. Just beneath the head the bone is observed to be constricted; this is known as the anatomical neck. Beneath this, externally and anteriorly, are two eminences, separated by a groove; the outer, and much the larger, is called the greater; the inner the lesser tuberosity; the groove is called bicipital, and its edges are known as the anterior and posterior bicipital ridges respectively. That portion of the bone immediately below the tuberosities is known as the surgical neck.

The lower extremity of the humerus presents the two condyles, one on either side, the inner being the more prominent. Passing up from each is a ridge called condyloid, the external being more prominent. The extremity bears an irregular articular surface, which is formed of the following parts from without inward: a rounded articular projection known as the eminentia capitata, whose articular surface encroaches more on the front than the rear and is intended for articulation with the radius; just internal to this is a non-articular antero-posterior groove; internal to this a pulley-like articular surface—consisting of two antero-posterior ridges, with an intervening groove, which is known as the pulley, or trochlea of the humerus and articulates with the ulna. Just above the trochlea in front is a depression called the coronoid fossa and just above it behind is another deeper depression called the olecranoid fossa.

The shaft of the humerus is three-sided, or prismoid, presenting three surfaces and three borders.

The anterior border begins at the front of the greater tuberosity and terminates at the coronoid fossa. The external border begins at the back of the greater tuberosity and terminates in the external condyloid ridge. The internal border begins at the lesser tuberosity and terminates at the internal condyloid ridge.

The external face presents about the middle the union, at an acute angle, of two rough ridges approaching each other from above; this is known as the deltoid V. Below this the external face becomes anterior and concave. The internal face shows, above, the bicipital groove. The posterior face is smooth, convex and obliquely grooved about its centre from within downward and outward, the groove being called the musculo-spiral.

SUMMARY.

Upper extremity—Hemispherical head; anatomical neck. Greater and lesser tuberosities. Bicipital groove and ridges. Surgical neck.

Lower Extremity—External and internal condyles. From without inward, enimentia capitata, groove, trochlea; coronoid fossa in front, olecranoid behind.

Shaft—External Face: Deltoid "V"; below, anterior and concave.
Internal Face: Bicipital groove.
Posterior Face: Smooth, musculo-spiral groove.

The Skeleton of the Forearm.

The skeleton of the forearm consists of two bones lying side by side, the inner known as the ulna, the outer as radius.

The Ulna.

The ulna is the inner bone of the forearm, and is divided, like all long bones, into a shaft and two extremities.

The upper extremity is much the larger and may be described as consisting of two parts or processes, one of which, the olecranon, terminates the extremity, the other, the coronoid, projecting from the base of the olecranon forward. Sweeping between these and appropriating the front of the olecranon and the upper part of the coronoid, is an extensive articular surface, corresponding to the trochlea of the humerus, and called the greater sigmoid cavity, which presents a deep concavity in profile and a vertical ridge along its entire centre. Just where we might suppose the two processes to meet is a notch on each side. Posteriorly, the olecranon is rough and triangular; superiorly, it presents a quadrilateral rough surface; anteriorly it is concave and forms part of the great sigmoid cavity, and its central, vertical ridge; it terminates antero-superiorly in a small but marked projection, overhanging the sigmoid cavity, called its beak; extending outward and downward, diverging on each side from immediately behind the beak, and continuing to a point just posterior to the edge of the greater sigmoid cavity, is a groove.

The coronoid process juts forward from the base of the olecranon. Above it forms a part of the great sigmoid cavity and its central ridge; below it shows a rough concave surface for the attachment of a muscle—the brachialis anticus; on its outer side is seen an articular concavity, called the lesser sigmoid cavity, in which the rim of the head of the radius plays, below which is a depressed, rough triangular surface.

The lower extremity of the ulna is much smaller than the upper, and consists of two projections separated by a notch; the inner is the smaller and longer and comes to an apex; it is called the styloid process of the ulna. The outer process is called the capitulum ulnæ, and is articular-like on its summit; circumscribing the rim of the outer half of this is an articular surface against which the lower end of the radius plays.

The shaft of the ulna is three-sided, hence presenting three borders and three surfaces. The anterior border begins above at the inner side of the coronoid process, and terminates at the front of the styloid process. The posterior border begins at the apex of the triangular posterior surface of the olecrannon and terminates at the back of the styloid process. The external border begins by the convergence of a line from each side of the lesser sigmoid cavity, and terminates at the capitulum ulnæ. This border is sharp and prominent and is called the interosseous border.

The anterior face is concave. The internal face is concave above

and convex below. The posterior face shows from above downward a triangular surface, an oblique ridge and a vertical ridge.

SUMMARY.

Upper Extremity—Olecranon and coronoid processes, greater and lesser sigmoid cavities.

Olecranon—Anterior Face—Articular vertical ridge.
Posterior Face—Triangular.
Superior Face—Quadrilateral; beak and groove.

Coronoid—Superior Face—Articular, ridged.
Inferior Face—Concave; muscular impression.
External Edge—Lesser sigmoid cavity.

Greater Sigmoid Cavity—Ridge in centre, notch on each side.

Lower Extremity—Styloid process on inner side, external to it a notch; external to this, capitulum ulnæ, articular-like on summit and articular on outer side.

Shaft—Anterior, posterior and internal surfaces.
Anterior, posterior and external borders.

Anterior surface concave.

Posterior surface from above, triangular depression, oblique and vertical ridges.

Internal surface concave above, convex below.

Radius.

The radius is the outer of the two bones of the forearm, and is divided, like other long bones, into a shaft and two extremities. Unlike the ulna, the upper extremity is much smaller than the lower. The upper extremity presents a head, upon whose summit is an articular cup-shaped depression for articulation with the enimentia capitata of the humerus. Surrounding this depression is an articular rim, and supporting these is a constricted portion called the neck, terminating below on the inner side, at a projection called the tubercle, or the bicipital tuberosity, which is divided by a ridge into a rough posterior and a smooth anterior portion.

Turning to the lower extremity, it is seen to be much larger than the upper, presenting upon its summit a triangular articular cavity, carpal, having its apex outward, and terminating on the outer side in a pointed projection called the styloid process. The carpal cavity is seen to be crossed about its centre by a ridge and terminates at the inner edge of the bone, upon which is a narrow, non-articular concave portion, above which is a concave articular strip called the sigmoid cavity of the radius.

The anterior aspect of the lower extremity is rough and projecting; the posterior has five vertical grooves, two of which are on the styloid process.

The shaft of the radius presents three surfaces and three borders. The anterior border begins at the front of the bicipital tuberosity and passing downward and outward forms what is called the oblique ridge, and terminates at the styloid process. The posterior border, beginning at the posterior part of the tuberosity, terminates behind the styloid process. The internal border or interosseous ridge begins above, also at the tuberosity and passes downward, sharp and prominent, to terminate by dividing into two lines which enclose the sigmoid cavity.

The anterior face is concave above and becomes wider and flat below. The posterior face is concave in the centre, but convex above and below. The external face is convex throughout.

SUMMARY.

Upper Extremity—small, head, cup, neck, tuberosity.

Lower Extremity—Large, articular, triangular carpal cavity with a ridge; styloid process, which, with posterior aspect, is grooved.

Shaft—Anterior Face—Concave above; becomes flat and wide below.

Posterior Face—concave in middle.

External Face—convex throughout.

Of the three borders the internal, or interosseous ridge is the sharpest and most prominent; and the external is oblique above.

The Hand.

The skeleton of the hand consists of the skeleton of the carpus, the metacarpus and phalanges.

The Carpus.

The skeleton of the carpus, or wrist consists of seven small, irregular bones arranged in two rows one above the other; in the upper row are three bones, arranged in the following order from without inward: 1st, the Scaphoid; 2d, the Semilunar; 3d, the Cuneiform, on the front of which plays a sesamoid bone, called the pisiform. In the lower row, in the same order, are: 1st, the Trapezium, 2d, Trapezoid; 3d, Os Magnum; 4th, Unciform. The bones of the upper row articulate laterally with one another; the bones on the inner and outer side, respectively, have no bones on the inner side of the one and the outer side of the other, and hence there is no articular surface on that aspect of the bones. It must further be noted that viewed from the back there appears to be but three bones in the upper row, placed laterally scaphoid, semi-

lunar, cuneiform; but viewed from the front the pisiform is seen perched upon the front of the cuneiform, so that the latter bone has no articular facet on its inner side. Above, the upper row presents a convex articular surface forming the condyle of the wrist joint; so that in this direction all the bones of the row are articular. Below, the upper row presents a sinuous articular surface, formed by all three bones, for articulation with the lower row; externally this surface is convex, internally concave. The bones of the lower row, like those of the upper, articulate laterally with one another, the outer and inner bones, of course, not being articular in a corresponding direction. Above, the lower row presents a sinuous articular surface, corresponding to that of the upper row with which it articulates, being convex internally and concave externally. Below, the lower row is articular to receive the bones of the Metacarpus. The bones of neither row are articular on the front, or palmar aspect, nor on the back, or dorsal aspect, the carpus being but one bone deep; there is one exception to this in the fact that the pisiform lies on the front of the cuneiform, and consequently the former has an articular dorsal aspect, and the latter an articular palmar aspect.

The carpus, taken as a whole, is markedly arched transversely, the convexity of the arch being dorsal; for this reason the separate bones, being the elements of the arch, must necessarily be thicker posteriorly. The semilunar is an exception. Hence the dorsal can be easily discriminated from the palmar aspect. Bearing this fact in mind, and also that in the upper row, the general contour for the articular surface is convex and of the lower concave, except for the scaphoid, the individual bones may be recognized. The scaphoid has no articular facet on the outer side but a round tubercle, and its lower surface is convex. It is said to be in form "boat like," coming to a point at the tuberosity on the outer side. The semilunar is crescentic in outline and has a deep articular cavity below; its palmar aspect is larger than the dorsal. The cuneiform presents a non-articular lateral aspect internally, an articular facet anteriorly for the pisiform, and is wedge-shaped, the base being external. The pisiform is known by its small size and by having but one articular facet. The trapezium is non-articular on its outer side, and is especially distinguished by having on its palmar aspect a deep groove bounded externally by a ridge terminating in a prominent tubercle. The trapezoid is the most difficult to discriminate and is best recognized by exclusion. The Os Magnum is the largest bone of the carpus, presenting a rounded articular head superiorly. The unciform is recognized by the hook-like process projecting from the palmar aspect.

Metacarpus.

The metacarpus is formed by five bones classed as long bones; four of these, for the four fingers, being nearly parallel, while the fifth—for the thumb—recedes from the others as it descends. The metacarpal bones articulate above with the lower row of the carpus; below with the upper extremity of the first phalanges. At their upper ends they articulate laterally with one another, except the metacarpal bone of the thumb; but at the lower end they do not articulate with one another. The metacarpus, like the carpus, is arched transversely, the convexity being posterior. One of its constituents may be thus described:

A Typical Metacarpal Bone.

Each metacarpal bone being a long bone, presents a shaft and two extremities. The upper extremity, generally called the base, is quadrilateral. It is articular on its summit and on its sides.

The lower extremity, called the head, is terminated by an articular head which is oblong antero-posteriorly and is articular higher in front than behind. The lower extremity presents a depression on either side, and behind this a tubercle; it is flattened posteriorly and grooved anteriorly.

The shaft is triangular, and is arched longitudinally with the convexity backward. The lateral faces are slightly concave, and are separated anteriorly by a sharp border. The posterior face presents at its upper part a central longitudinal ridge and on either side of this ridge a slight depression; just below the centre of the surface the ridge divides into two, which, separating, gradually descend each to the tubercle above the lateral depression on the lower extremity of the bone, that portion of the face between them being flattened.

This description applies in general more or less closely to all the metacarpal bones, but each possesses appearances characteristic of itself, by which it may be discriminated. Each bone is known by the name of the finger it supports; they are also known by number from without inward.

The metacarpal bone of the thumb is the shortest, the largest and is somewhat flattened from before backward. It has upon the summit of its base a saddle-shaped, concavo-convex, articular surface and has no lateral articular facet.

The metacarpal bone of the index finger is the longest, is next in size to that of the thumb and presents on its base two articular facets, one on the summit and one lateral.

The metacarpal bone of the middle finger is next in size and length, and presents three articular facets on its base, one on the summit and two lateral, and a styloid process projecting upward on its dorsal aspect.

The metacarpal bone of the ring finger is next in size and length; its base presenting three facets—one on the summit and two lateral—the outer of which is divided by a groove.

The metacarpal bone of the little finger is smallest and next to the shortest; its base presents two articular facets, one on the summit and one on the outer side; on the inner side of the base is a rough prominent tuberosity.

Phalanges.

The phalanges consist of three rows of long bones, extending from the heads of the metacarpal bones to the tips of the fingers. The rows are numbered from the metacarpal bones, the third row being usually called "ungual." The thumb has but two phalanges, the characteristic second phalanx being replaced by an ungual, or third.

The first phalanx is longer than the second, its shaft is semi-cylindrical, with its posterior surface convex. Its base presents on its summit an articular cavity for the head of a metacarpal bone. The head, or lower extremity, presents a pulley or trochlea for articulation with the base of the second phalanx.

The second phalanx presents on its base a receiving articular surface for the trochlea on the head of the first phalanx. Its shaft is semi-cylindrical and convex posteriorly. Its lower extremity, or head, presents a trochlea for articulatiou with the third phalanx.

The third, or ungual phalanx, presents on its base an articular surface to receive the trochlea of the second; it then becomes narrow and again wider, flatter and rougher to support the nail and the tissues of the palp of the finger.

The Skeleton of the Lower Extremity.

The skeleton of the lower extremity consists of the skeleton of the hip, thigh, leg and foot.

Os Innominatum.

The two ossa innominata, each forming the skeleton of the hip, are elements of the articulated pelvis, each articulating behind with the sacrum, in front with its fellow, and below with the thigh bone, or femur. Each bone in the young subject is seen to consist of three parts: (1st) An upper, posterior large portion called the ilium ; (2d) a front portion called the pubes; (3d) the lower division called ischium. These three elements,

known each as a separate bone, meet in the articular cavity for the head of the femur, the acetabulum, and in the adult are firmly ossified together, though in Anatomy they are described separately.

Ilium.

The ilium is the upper, posterior and largest portion of the os innominatum, and presents for examination a crest, two faces and projections.

The crest is the upper border of the bone, is sinuous in outline, resembling the italic letter *S*, is thinnest somewhere about the centre, and terminates in front in a projection, called the anterior superior spinous process of the ilium, which has just below it another projection, called anterior inferior spinous process of the ilium; the two processes being separated by a notch. Some anatomists say the ilium has an anterior border occupied by the anterior inferior spinous process, the notch above it, and the articular surface of the pubes below it. The crest terminates behind in a projection known as the posterior superior spinous process of the ilium, separated by a notch from a similar projection below it, the posterior inferior spinous process of the ilium, below which is the greater sacro-sciatic notch.

The surfaces of the ilium are external and internal. The external surface is called the dorsum ilii, and extends from the crest to the acetabulum. It is concave posteriorly for more than half its extent, and convex anteriorly. It presents three linear elevations, called the curved lines of the dorsum ilii, superior, inferior and middle. Of these lines the superior is best marked, the others being indistinct. The superior curved line extends from the upper margin of the great sacro-sciatic notch nearly vertically to the crest. The middle begins near the same point, generally by a groove and, curving upward and forward, terminates near the anterior extremity of the crest. The inferior commences near the anterior extremity of the great sacro-sciatic notch, and terminates about the anterior inferior spinous process.

The internal face of the ilium is in front concave and smooth; this portion being called the iliac fossa. Behind the fossa, and separated from it by a ridge, is an ear-shaped surface for articulation with the sacrum; behind this is a rough surface.

The Ischium.

The ischium is the lowest portion of the os innominatum, and consists of a body, ramus and tuberosity.

The Body presents three faces and two borders. The internal surface is smooth, sloping, triangular or quadrilateral, flat or slightly concave,

and broader above than below. The external face presents a part of the acetabulum and just below it a deep horizontal groove. The posterior face is convex and quadrilateral.

The posterior border presents a prominence called the spine of the ischium, above which is a part of the greater sacro-sciatic notch; below the spine is a smaller depression, called the lesser sacro-sciatic notch.

The anterior border is sharp and thin, and forms the posterior boundary of a foramen called the thyroid, or obturator foramen.

The tuberosity is the thick, prominent, rough lower portion of the ischium, upon which the trunk rests in the sitting posture, and is marked by muscular and ligamentous attachments.

The ramus of the ischium passes upward and inward from the tuberosity, forming a part of the anterior boundary of the obturator foramen, and meets the descending ramus of the pubes; the point of union being marked by a ridge.

Pubes.

The pubes, or os pubis, is the front portion of the os innominatum, and consists of a body and ramus.

The body is the horizontal portion extending from the acetabulum to symphysis pubis. The symphysis pubis is the surface by which the bones of opposite sides articulate, through the intervention of cartilage; it is rough and marked by osseous projections, oval in outline, with the large end upward and its long diameter downward and backward. At the inner termination of the body, just at the upper extremity of the symphysis, is the angle of the pubes; extending outward from this, on the upper border of the body, is a rough ridge, about three-fourths of an inch in length, called the crest, which terminates in a projection called the spine; external to this is a triangular surface, the pectineal triangle, having its apex at the spine and its base outward at a bulge called the pectineal eminence; the triangle is bounded behind by a ridge, the pectineal line; in front it is limited by the anterior surface of the body.

The lower border of the body forms the upper boundary of the obturator foramen and presents a deep groove, running obliquely from without inwards and forward. The posterior face is smooth and concave. The anterior face is rough and becomes flat towards the symphysis, narrow and convex externally.

The ramus of the pubes passes downwards and outward from the symphysis to meet the ramus of the ischium.

Besides those already described, the os innominatum presents two other appearances of great importance—the Acetabulum, or cotyloid cavity, and the Thyroid, or Obturator Foramen.

Acetabulum.

The acetabulum, or cotyloid cavity, is situated on the outer face and at the point of union of the three bones. They furnish unequal proportions to it; the ilium gives rather less than two-fifths; the ischium rather more than two-fifths; and the pubes one-fifth. It is a deep articular cavity corresponding to the head of the femur with which it articulates; it is surrounded by a prominent rim, which is wanting at its lower inner part, leaving a notch called the cotyloid; in the bottom near this notch is a rough depression, intended to receive, in the living subject, a mass of fatty tissue. The acetabulum looks downward, forward and outward.

Obturator Foramen.

The obturator or thyroid foramen, is situated in the front inner part of the os innominatum and is bounded as follows: behind, by the anterior border of the body of the ischium; in front, by the ramus of the ischium below and the ramus of the pubes above; above, by the lower border of the body of the pubes; below, it terminates at the junction of the body and ramus of the ischium.

It is more or less triangular in shape, observably more so in the female than in the male; its base is above and apex below; its long diameter is downward and outward. In the living subject it is closed by a strong connective tissue membrane, which bears the name of the foramen.

SUMMARY.

Os Innominatum—Ilium—Superior border or crest; sinuous, thinnest about the centre—two spinous processes—Superior Anterior and Superior Posterior, Anterior border—upper half has anterior superior spinous process, notch and anterior inferior spinous process—lower half continuous with pubes and enters acetabulum—Posterior border—Posterior superior and inferior spinous processes, notches, greater and lesser sacrosciatic notches.

Dorsum, or external face—convex anteriorly, concave more than half posteriorly; superior, middle and inferior curved lines, the surface extends from crest to acetabulum.

Internal face—iliac fossa; pectineal ridge; auricular surface and rough surface.

Ischium—Body—Internal surface, smooth, sloping, triangular, more or less flat and narrowing below.

External surface—Acetabulum and horizontal groove below.

Posterior surface—convex and quadrilateral.

Posterior Border—spine—greater and lesser sciatic notches.

Anterior Border—sharp and thin.

Tuberosity—Thick, rough, lower portion has muscular impressions.

Ramus—runs upward and inward and joins ramus of pubes.

Pubes—Body—Symphysis, rough, oval, long diameter downward and backward.

Posterior Face—concave and smooth.

Anterior Face—flat, rough internally, convex externally.

Upper border—Angle, crest, spine, pectineal line triangle and eminence.

Lower border—oblique groove.

Ramus—descends downward and outward to join ramus of ischium.

Pelvis.

The pelvis is the cavity circumscribed by the sacrum, coccyx and two ossa innominata, containing in the living subject some of the small intestine, a part of the large intestine, and the genito urinary apparatus, in part. It is bounded behind by the sacrum and coccyx and throughout the rest of its extent by the ossa innominata. It is divided into two portions, the false pelvis and the true. The false pelvis is that portion between the two iliac fossæ bounded behind by the sacrum, while in front it has no bony wall. It extends from the crest of the ilium above to the pectineal line below. This pectineal line, also called linea-ilio-pectinea, is a prominent ridge extending around the os innominatum from the symphysis pubis to the sacro-iliac symphysis. At the linea-ilio-pectinea the pelvis is suddenly contracted and the true pelvis begins. The plane circumscribed by the ilio-pectineal line is called, the brim or inlet of the pelvis, or superior strait of the pelvis. The true pelvis thus extends from this brim downward to what is called the outlet, or inferior strait of the pelvis. The outlet is limited in front by the lower end of the symphysis pubis; the arch formed by the divergence of the pubic rami being called the pubic, or sub-pubic arch. Behind, the outlet is limited by the tip of the coccyx. Laterally the outlet is bounded by the tuber ischii. The pelvis is so attached to the vertebral column as to render the plane of the inlet oblique, from behind downward and forward, and so great is this obliquity that the top of the symphysis pubis is about four inches below the level of the promontory of the sacrum. The so-called axis of the superior strait is an imaginary line, perpendicular to the plane of the brim and cutting it at its centre. The true pelvis is much deeper behind than in front, measuring posteriorly five inches, laterally three and one-half

inches, and at the pubes one and one-half inches. Besides these measurements, obstetricians employ others, as of the outlet and inlet, called diameters. The diameters usually given are for the inlet, antero-posterior, transverse and oblique; for the outlet antero-posterior and transverse.

The objects observable on the exterior of the pelvis are as follows: in front the symphysis pubis and below this the pubic arch; on either side the obturator foramen, farther out the acetabulum; behind this the greater and lesser sciatic notches, separated by the ischiatic spine; on the centre behind is the sacral spine.

The pelvis differs in the two sexes; the characteristic points in the female are as follows: 1st, the thyroid foramen is more distinctly triangular; 2d, the pelvis is more capacious—measuring more transversely and antero-posteriorly, but less vertically; 3d, the angle of the pubic arch is greater by 10°, measuring from 90° to 100°.

The pelvis in the negro is observably smaller than in the Caucasian.

Femur.

The femur, or thigh bone, forms the skeleton of the thigh, which is the segment of the limb between the hip joint above and the knee below. It is the longest bone in the body, and is divisible into a shaft and two extremities.

The Upper Extremity is terminated by an articular head which is received into the acetabulum. The head forms about two-thirds of a sphere, and has just below and behind its centre a rough depression. Supporting the head is the neck, which is oblique in the adult, but becomes nearly horizontal in old age; it is constricted just below the head, but greatly enlarges as it approaches the shaft; the lower border of the neck is nearly twice as long as the upper; its vertical diameter is 50% greater than its antero-posterior. The upper border of the neck terminates below at a prominent process, projecting upward, and called the trochanter major. The outer surface of the great trochanter is rough and marked by muscular impressions; at the inner side of its base is a depression called the digital fossa.

The lower border of the neck terminates below at the smaller projection known as the trochanter minor, which is situated on the inner side of the bone. Passing between the two trochanters behind is a rough ridge called the posterior inter-trochanteric line. Extending downward and inward from the front of the greater trochanter, and passing below and in front of the lesser trochanter, is another ridge called the spiral line of the femur, or, by some, the anterior inter-trochanteric

line. Some anatomists say that a rough ridge descends, for two inches, from about the middle of the posterior inter-trochanteric line and call it the linea quadrati. It is invisible.

The lower extremity expands laterally and presents a broad articular surface, divided into two condyles, internal and external, by an antero-posterior depression, which is deep and rough behind and called, in this part, the inter-condyloid notch; but in front it is shallow and articular and forms, with the condyle on either side, a trochlea. The two condyles are dissimilar ; the outer is broader, its articular surface extends higher up in front, and when the femur is held vertically on a plane surface it is seen to be some half an inch shorter than the inner, this being due to the fact that the anatomical position of the femur is not vertical, but its lower extremity approaches its fellow very closely, whereas the upper extremities are separated by the width of the pelvis. On the outer side of the outer condyle is a prominence, the outer tuberosity, having just below a rough groove for the origin of a muscle, the popliteus. On the inner side of the inner condyle is a similar projection, the inner tuberosity. Looking at the posterior aspect of the two condyles, there is seen on each, just above its articular surface, a slight depression for the origin of a corresponding head of the gastrocnemius muscle.

The shaft of the femur is triangular on cross section, and is perceptibly bowed forward. It has three surfaces and three borders. The surfaces are two lateral and an anterior; the lateral surfaces are slightly concave; the anterior convex and smooth. The borders are two lateral, which are rounded, and a posterior, which is always known as the linea aspera. The linea aspera is rough, prominent and lipped; below, at the lower third of the femur, it divides into two lines, the two condyloid ridges, which diverge to the condyles, leaving a triangular interval on the back of the lower part of the femur. Just below the apex of this triangle the internal condyloid ridge is crossed obliquely by a broad, shallow groove, produced by the passage of the femoral artery. The outer condyloid ridge is the more prominent. About the upper third of the femur the linea aspera divides into three lines—1st, one to the base of the great trochanter; 2d, one to the lesser trochanter; 3d, one which, passing in front of the trochanter minor, becomes the spiral, or anterior inter-trochanteric line.

SUMMARY.

Upper Extremity—Head two-thirds sphere, pit, neck, two trochanters, two inter-trochanteric lines. Neck, oblique, contracted below head, then enlarged. Lower border longer—vertical diameter greater. Great trochanter convex and rough externally, pit within and behind.

Lower Extremity—Two condyles, trochlea, inter-condyloid fossa. Tuberosity on each condyle; below the outer a groove. Outer condyle broader and shorter.

Shaft—Directed obliquely downward and inward Anterior Face convex; Lateral faces slightly concave. Borders—Two lateral rounded—Posterior is linea-aspera; divides below into two condyloid ridges, one to each condyle; above, into three ridges, one to each trochanter and one to spiral line.

Tibia.

The skeleton of the leg, which extends from the knee to the ankle, consists of two bones placed side by side and of unequal size; the tibia, or inner bone, being twice the size of the outer bone, or fibula.

The tibia, like all long bones, consists of a shaft and two extremities. The upper extremity bears upon its summit two shallow articular cavities, situated beside each other and called glenoid cavities, these receive the condyles of the femur, and in correspondence with them, are dissimilar, the outer being about circular and the inner oval. Between the glenoid cavities is a bifurcated projection, the spine. On the front of the bone, about one and one-half inches from the upper limit, is a large process, called the anterior tubercle of the tibia, smooth above and rough below; above this the surface is smooth and triangular. The portion of the bone on which the glenoid cavities rest, projects laterally and is known as a tuberosity, internal and external. The internal tuberosity presents a horizontal groove; the external, a circular, articular facet, posteriorly, for articulation with the fibula.

The lower extremity is four sided, one-half the size of the upper and grooved posteriorly; projecting downward from the inner side is a process, called the internal malleolus, with its inner face rough and convex, its outer face triangular and articular, and its posterior border grooved.

On its summit the lower extremity has a quadrilateral articular surface, continuous with the one on the outer face of the internal malleolus; it has a slight antero-posterior ridge across its centre. On the outer side of the lower extremity is a rough depression, extending upward an inch or so; this depression sometimes terminates below in a narrow articular surface.

The shaft is three sided, having an internal, external and posterior surface, an anterior and two lateral borders. The internal face is convex and subcutaneous. The external face is concave above and becomes convex and anterior below. The posterior face has, at its upper part, an oblique ridge running downward and inward, called the popliteal line; above this

is a triangular surface called the popliteal triangle. Running down the centre of the posterior face, from the popliteal line, is a vertical ridge.

The anterior border, known as the crest, is sharp, prominent and sinuous. Of the two lateral borders, the external is much the sharper and more prominent.

SUMMARY.

Upper Extremity—Inner tuberosity grooved; outer flat, articular facet behind; outer gleniod cavity circular; inner oval; Spine—anterior tubercle, triangular flat surface.

Lower Extremity—Square, half size of upper, grooved posteriorly. Articular cavity crossed by antero-posterior ridge. Outer side, rough depression, which may terminate below in articular facet. Inner side internal malleolus, whose inner face is convex, subcutaneous and rough, whose outer face is triangular and articular, and whose posterior border is grooved.

Shaft—Internal face convex and subcutaneous; outer face concave above and anterior below; posterior face, popliteal line and triangle, and below a vertical ridge. Anterior border sharp and prominent, sinuous and called crest or shin. Of the lateral borders, external is the more prominent and sharp.

Patella.

The patella, or knee pan, is found on the front of the knee joint. It is really nothing more than a sesamoid bone developed in the tendon of the triceps extensor cruris. It is somewhat heart-shaped, the large end being up. It presents two faces; the anterior surface is convex and rough; the posterior is articular, presenting two portions separated by a vertical ridge. These are intended to play on the condyles of the femur, and, in correspondence with the shape of the latter, are of different size, the outer being much the larger. The outer edge is the thinner.

Fibula.

The fibula is the outer bone of the leg, and, like all long bones, is divisible into a shaft and two extremities. The upper extremity is more or less globular, presenting on its inner face a round, slightly concave, or flat articular facet to articulate with the one found on the outer tuberosity of the tibia; the outer aspect is rough and convex; a styloid process projects upward from it.

The lower extremity is generally known as the external malleolus. It is more or less distinctly triangular; its outer aspect is rough and subcutaneous; its inner is articular, above which is a deep, rough surface, be-

low which is a rough depression; its anterior border is narrow and convex; its posterior, broad, rough and vertical.

The shaft is twisted, and presents three faces, which change their relative positions in different parts of the bone. Superiorly the faces are external, internal and posterior, the internal face being concave; as they descend the external face becomes posterior, the posterior becomes internal, and the internal becomes anterior. On the latter is a sharp vertical ridge for the interosseous membrane.

SUMMARY.

Upper Extremity—Rounded, circular facet on inner aspect. External face convex and rough. Styloid process above.

Lower Extremity, or External Malleolus—Triangular; external face convex and rough; internal face, articular facet above and deep, rough pit below; anterior border narrow, posterior broader.

Shaft—External face becomes posterior below.
Posterior face becomes internal below.
Internal face becomes anterior below.
Internal is concave, and has interosseous ridge.

Foot.

The foot bears a strong resemblance to the hand, differing essentially from it, however, in that it is at right angles to the leg. It is arched both from before backward and from side to side, and consists of tarsus, metatarsus and phalanges.

Tarsus.

The tarsus consists of seven bones: os calcis, astragalus, scaphoid, cuboid and the three cuneiform bones—external, middle and internal.

Os Calcis.

This bone forms the posterior abutment of the arch of the foot and is known as the heel bone. It presents two extremities and four surfaces. The upper surface consists of two portions, one behind the other; the posterior portion is a rough rounded border; the anterior portion presents two articular surfaces, separated by an oblique groove; this groove is called the sulcus calcanei; the facet behind this is large, quadrilateral and convex; the one in front small, oval and concave. The inferior surface is rough and presents, towards its posterior termination, two tuberosities, one external and the other, much longer, internal. The external surface is convex with two grooves separated by a ridge. The

internal surface is concave and grooved. The posterior extremity is called the posterior tuberosity; it is smooth above and rough below. The anterior extremity is articular and concavo-convex.

Astragalus.

The astragalus lies between the tibia above and the os calcis below, and, like the latter, presents four surfaces and two extremities.

The superior surface is a trochlea for articulation with the tibia. The inferior surface is articular, and is divided into two facets by an oblique groove called the sulcus tali; this surface, articulating with the upper surface of the os calcis, is correspondingly formed, the facet behind the groove being large, square and concave, that in front small, oval and convex. When the two bones are articulated the sulcus calcanei and the sulcus tali form a canal called the sinus tarsi. The internal face is articular to a small extent for the internal malleolus. The external face presents a large triangular facet for the external malleolus. The anterior extremity is a rounded articular head, supported by a constricted portion, the neck. The posterior extremity is narrow and notched. Thus it is seen that every aspect of the astragalus, except the posterior, presents an articular surface.

Cuboid.

The cuboid lies between the os calcis behind and the fourth and fifth metatarsal bones in front. It is described as having four surfaces and two extremities. The upper surface is rough and flat. The lower surface is rough with a deep groove; behind this groove is a ridge. The outer surface is narrow, notched and rough. The inner surface is square, broad and articular above. The anterior extremity has two articular facets separated by a vertical ridge. The posterior extremity is a concavo convex articular surface.

Scaphoid.

The scaphoid receives the head of the astragalus behind and articulates in front with the three cuneiform bones. It presents two surfaces, two borders and two extremities. The posterior surface is concave and articular. The anterior surface presents three articular facets separated by two vertical ridges. The superior border is broad and rough; the inferior narrow and rough. The inner extremity is bluntly pointed and is called the tuberosity of the scaphoid; the outer is broader and sometimes articular, above, for the cuboid.

The three cuneiform bones, the remaining bones of the tarsus, lie in a transverse row between the scaphoid, behind, and the first, second and

third metatarsal bones, in front; between the cuboid externally and the inner border of the foot, internally.

Internal Cuneiform.

The internal cuneiform, like the other two, is of an irregular wedge shape and lies on the inner side of the tarsus, between the first metatarsal bone and the scaphoid and has to its outer side the middle cuneiform. It is the largest of the cuneiform bones and has its base below.

The inner face is rough and convex, and has at the anterior, inferior angle a smooth facet, over which a tendon plays. The external face is concave, and at its upper posterior part is articular. The posterior face is articular and concave and smaller than the anterior. The anterior face is articular, convex and kidney shaped. The inferior face is rough and is the base of the bone; it presents at its posterior part a tuberosity. The superior face is narrow and rough.

Middle Cuneiform.

The middle cuneiform lies between the inner cuneiform on the inner, and the outer cuneiform, on the outer side; between the scaphoid, behind, and the second metatarsal in front. It is the smallest of the cuneiform bones and has its base above. It does not reach as far forward as the bone on either side, thus leaving a cavity in front into which is received the base of the second metatarsal bone. The internal face has two articular facets, meeting at an angle. The external face has one articular facet.

External Cuneiform.

The external cuneiform is next in size to the internal and lies between the middle cuneiform, internally, and the cuboid, externally, and the scaphoid, posteriorly, and the third metatarsal, anteriorly. Its base is above.

Metatarsus.

The metatarsus consists of five bones stretching from the tarsus, behind, to the phalanges, in front, these bones are known by number, beginning with the bone on the inner side. They are long bones, and, of course, have a shaft and two extremities: the posterior extremity is called the base and the anterior, the head. They grow distinctly smaller towards their anterior extremities.

The first metatarsal bone is the largest, although the shortest. Like the others it presents an articular surface on the summit of its base, but has not generally, as the others have, lateral facets, for it does not articulate

with the second metatarsal bone. The lower aspect of the base presents a rough prominence.

The anterior extremity, like that of the others, furnishes an oblong articular head, or condyle. On the lower aspect of this extremity is a ridge separating two grooves.

The second metatarsal bone is the longest and is next in size to the first. Its base is received into the interval between the internal and external cuneiform bones.

The fifth metatarsal bone can be distinguished from the others by having an articular facet on but one side of its base; all the rest, except the first, being articular on both sides. It is the smallest and has on the outer side of its base a prominent process.

Phalanges.

The phalanges of the toes, like those of the fingers, are arranged in three rows, except that the great toe has, like the thumb, but two phalanges, the place of the second being taken by an ungual. They resemble those of the hand so closely that a separate description is not called for. Except those of the great toe, they are smaller than in the hand; the shaft of the second row being scarcely more than a neck.

The Skeleton of the Head.

The skeleton of the head, or skull, consists of two portions, the bones of the cranium and those of the face.

Cranium.

The cranium is the upper posterior division of the skull, and is formed by the union of eight bones—occipital, frontal, sphenoid, ethmoid, two parietal and two temporal. These become securely ossified together in mature life, and can be separated only in the young subject.

Occipital.

The occipital bone is situated at the posterior part of the cranium, and presents for examination two surfaces, four angles and four borders.

The posterior surface, sometimes erroneously called external, is convex, and presents above its centre an eminence called the posterior occipital protuberance, sometimes also wrongly called external; curving outward from this on either side is a rough ridge called the superior curved line; passing downward from the protuberance to a large aperture—the foramen magnum—is a sharp ridge, the occipital crest; arching outward on either side from the middle of the crest, and concentric with

the superior curved line is the inferior curved line. At the lower termination of the crest is seen the foramen magnum, a large oval opening, having its antero-posterior diameter the longer and its larger end behind. On either side of the front half of the foramen magnum is seen the condyle for articulation with the superior articular process of the atlas; it is oval, convex, articular, and directed obliquely forward and inward. Just behind the condyle is a depression, the posterior condyloid fossa, with occasionally a foramen opening into it—the posterior condyloid foramen. In front of the condyle is the anterior condyloid foramen. Passing outward from the condyle is a rounded elevated ridge, the transverse process. On the inner aspect of the condyle is a tubercle. In front of the foramen magnum is the basilar process; it is horizontal, quadrilateral, convex, and presents an antero-posterior ridge, the pharyngeal spine.

The anterior face is concave and presents four ridges, meeting at right angles, about the centre, called the crucial ridge, or occipital cross; each ridge is called an arm of the cross. Three of these ridges are grooved; while the fourth, which is the inferior, is sharp and not grooved until it approaches the foramen magnum. At the point where the four arms meet there is an eminence called the anterior occipital protuberance. Above each lateral arm of the cross there is a shallow depression, the cerebral fossa; below each lateral arm is another depression, the cerebellar fossa. At the termination of the lower arm is the foramen magnum, and on each side of this the anterior condyloid foramen. In front, and to each side of the foramen magnum is a smooth broad groove for the termination of the lateral sinus. In front of the foramen magnum is the basilar process, which, as on its inferior surface, is nearly horizontal and quadrilateral, but is here concave to sustain the medulla oblongata.

The angles are superior, inferior and two lateral. The lateral angles are each situated where the groove in the lateral limb of the crucial ridge, strikes the border of the bone. The inferior angle is the truncated extremity of the basilar process, and articulates with the body of the sphenoid.

The superior angle juts into the interval formed by the union of the posterior superior angles of the parietal bones.

The borders are two superior and two inferior—Each superior border is serrated for articulation with the parietal bone.

Each inferior border articulates with the temporal bone, mastoid and petrous portions; it is interrupted about its centre by a protuberance, the jugular eminence, in front of which is a depression; the jugular fossa.

SUMMARY.

Posterior surface—convex, posterior protuberance, crest; superior and inferior curved lines, foramen magnum, which is large, oval, long diameter, antero-posterior, large end behind; condyles, each convex, oval, directed obliquely inward and forward, anterior condyloid foramen, posterior condyloid fossa, and, perhaps, foramen; tubercles for check ligament, transverse process, basilar process, which is square, horizontal, convex and has pharyngeal spine.

Anterior surface—concave, anterior protuberance, crucial ridge, with all its limbs grooved except the lower, cerebral and cerebellar fossæ, foramen magnum, anterior condyloid foramen, groove for the lateral sinus, basilar process, which is here square and concave.

Angles—superior, inferior and two lateral.

Borders—two superior serrated for parietal bones, two inferior serrated for temporal bone, each interrupted about the centre by jugular eminence and in front of this is the jugular fossa.

Parietal.

The two parietal bones form the upper and most of the lateral wall of cranium, and are situated between the frontal and occipital bones, in front and behind, and the two temporal bones laterally. Each bone is divided into two surfaces, four borders and four angles.

The external surface is convex and presents a decided bulge about the centre, the parietal eminence; through this is seen running the temporal ridge, arching across this bone from the frontal; below the ridge, is the temporal fossa. Near the posterior superior angle is seen the parietal foramen, which is frequently absent.

The internal surface is mostly concave and is sunken in the centre into a fossa. It is marked by digital pits for lodging cerebral convolutions, and the arborescent furrows worn by the arteries. Along the edge of the superior border is seen the half of a groove, completed by the opposite bone, and formed by the longitudinal sinus.

The borders are four. The anterior, for articulation with the frontal bone, and the posterior, for the occipital, are serrated. The superior border, for articulation with its fellow, is straight, serrated and thick. The inferior border, for articulation with the squamous portion of the temporal bone, is short, curved and beveled at the expense of the outer table.

The angles are four. The anterior superior and the posterior superior are right angles. The anterior inferior is long, thin and marked on its inner aspect by a furrow formed by the middle meningeal artery. The

posterior inferior is blunt and usually marked internally by the groove for the lateral sinus.

SUMMARY.

External Surface—convex; parietal eminence, temporal ridge, temporal fossa; parietal foramen.

Internal Surface—concave; pitted, furrowed, grooved by superior longitudinal sinus.

Borders—Anterior and posterior serrated. Superior, straight, thick and serrated. Inferior, short, arched and thin.

Angles—Anterior Superior and Posterior Superior are right angles. Anterior Inferior, prolonged and furrowed internally. Posterior Inferior, blunt and grooved within by lateral sinus.

Frontal.

The frontal bone is situated at the front and base of the cranium. In early life the bone consists of symmetrical lateral halves, separated by an unformed suture, which, however, becomes ossified later in life, though the bone could still be described as consisting of two similar lateral portions. The bone is described as being made up, in each of its lateral halves, of two portions—the vertical, or frontal, and the horizontal, or orbito-nasal portion.

The vertical portion forms the skeleton of the forehead and presents two surfaces and a lateral aspect. Upon the anterior surface, which is convex, there are seen superiorly a smooth, somewhat flattened surface; below this a bulge, called the frontal eminence; below this a broad, shallow, transverse groove; below this a transverse ridge, the superciliary; between this and the opposite ridge, on the middle line, is a prominence called the glabella, or nasal tuberosity. Below the superciliary ridge is seen the margin of the orbit, called the supra-orbital ridge, which terminates at the inner extremity in the internal angular process, and at its outer in the external angular process. About the inner third of the supra-orbital ridge is a notch, sometimes formed into a foramen, called the supra-orbital notch or foramen.

The posterior face of the vertical portion is concave and marked by digital pits and arborescent furrows for the arteries. In the middle line this surface presents superiorly a groove for the longitudinal sinus, which, as it descends, terminates in a ridge, at the extremity of which is a small foramen, called the foramen coecum.

The lateral aspect of the bone presents a ridge curving upward and backward from the external angular process, and called the temporal ridge; below this the surface is sunken and forms part of the temporal

fossa. Both the temporal ridge and fossa are only partially seen on the frontal bone, for, in the articulated skull, they are continued on to the parietal and temporal bones.

The horizontal portion consists of two lateral parts, the orbital plates, separated by a rectangular notch, the ethmoidal fissure. Each orbital plate presents an inferior and a superior surface. The inferior face is smooth, triangular and concave, the concavity being greatest behind the external angular process—the lachrymal fossa. It has, just within the supra-orbital notch, a depression called the fovea trochlearis.

The upper surface of the orbital plate is convex and rough, presenting irregular rough eminences.

The ethmoidal fissure is the rectangular notch separating the two orbital plates. In front of it is a roughened interval, between the two internal angular processes, called the nasal notch, descending from the centre of which is a long pointed process, the nasal spine. Upon the posterior surface of the nasal spine is a vertical ridge, on either side of which is a furrow and external to this an irregular opening leading to a hollow in the vertical portion called the frontal sinus. The frontal sinus, one on each side of the middle line, is an irregular cavity between the two tables of the vertical portion and gradually increases in size from the time it makes its appearance in early life.

The borders of the frontal bone are two—superior and inferior. The superior border is semicircular and serrated for articulation with the parietal bones. When examined closely it is seen to be bevelled superiorly at the expense of the inner table, and inferiorly at the expense of the outer.

The inferior border is the posterior termination of the orbital plates, interrupted in the centre by the ethmoidal notch. It is straight and articular with the lesser wing of the sphenoid.

At the angle of the junction of the two borders, there is a rough triangular surface, the sphenoidal triangle, for articulation with the greater wing of the sphenoid.

SUMMARY.

Vertical portion—Anterior face—convex; flat surface; frontal eminence; groove; superciliary ridge; nasal tuberosity; supra-orbital ridge; internal and external angular processes; supra-orbital foramen.

Posterior face—concave; pits; arterial furrows; central groove; ridge; foramen coecum.

Horizontal, or orbito—nasal portion—two orbital plates and the ethmoidal fissure.

Inferior surface—triangular, smooth, concave, fovea trochlearis.

Superior Surface—convex and rough.

Ethmoidal Fissure, nasal notch, nasal spine, ridge, on each side a groove and opening of frontal sinus.

Lateral aspect—temporal ridge and fossa.

Borders—Superior semicircular and serrated. Inferior straight and interrrupted by ethmoidal fissure.

At angle of union of two borders, a rough surface for greater wing of sphenoid, sphenoidal triangle.

Temporal.

The temporal bones are two, one to either side. Each bone is situated at the side and base of the cranium, its most prominent relation being derived from its position below the parietal. It is divided into three portions, squamous, mastoid and petrous.

The squamous portion is the front upper thin part, forming the thinnest part of the wall of the cranium. It presents for examination two surfaces and an upper, or semicircular border. The external surface is slightly convex, with arterial furrows and the extension on to it, from the parietal, of the temporal ridge. The most noticeable appearance on this face is the zygomatic process, which springs from the lower part of the squamous portion, first juts outward, it then twists, and is directed forward in a slightly oblique direction, receding from the bone a little as it advances; its external surface convex, its internal concave; its upper border is thin, the lower, thicker and slightly arched upward. Its anterior extremity is slightly beveled off into a rough surface, for articulation with the zygomatic process of the malar. The zygomatic process springs from the external surface of the squamous portion by two roots, an anterior and a posterior; the anterior is a broad well-marked ridge passing inwards to a smooth, rounded projection, the eminentia articularis, which forms the front boundary of the glenoid fossa; the posterior root divides into two branches, the upper is lost posteriorly in the temporal ridge, the lower—sometimes called the middle root of the zygoma descending to terminate in a slight prominence, the posterior glenoid process at a well marked crack, called the fissure of Glaser, which divides the glenoid fossa into two portions; that in front is smooth for the reception of the condyle of the lower jaw; that behind is rough. The glenoid fossa, as its name imports, is a concave surface, situated between the roots of the zygoma, bounded in front by the eminentia articularis and behind by the middle root of the zygoma and the vaginal process of the petrous portion, and divided as above stated, into two portions by

the fissure of Glaser. Where the anterior and posterior roots meet, the zygoma presents a prominence, called its tubercle.

The internal surface of the squamous portion is pitted and marked by arterial furrows.

The superior border is irregularly semicircular and beveled, articulating above with the parietal and anteriorly with the greater wing of the sphenoid.

The mastoid portion is the thick, posterior, cellular part of the temporal bone, and presents two surfaces and two borders.

The external surface is convex, subcutaneous and rough; posteriorly it generally presents a small foramen called the mastoid; inferiorly it terminates in a rough nipple-like process, the mastoid. Just at the base of the internal aspect of the mastoid process is a depression, the digastric fossa, and just internal to this a groove, the occipital.

The internal surface presents but one object, a groove for the lateral sinus, called the fossa sigmoidea.

The borders of the mastoid portion are the superior, which articulates with the posterior inferior angle of the parietal bone; and the posterior, which articulates with the occipital bone.

The petrous portion is a three-sided pyramid, its base being between and partly lost in the other two portions, from which it projects inward, forward and slightly downward, gradually tapering to its apex. It aids in the formation of the base of the skull, and is described as consisting of three faces, three borders, a base and an apex.

The posterior face looks backward and presents but two points worth observation: 1st, the internal auditory meatus, a large circular opening, situated about the middle of the face; 2d, behind and external to the internal auditory meatus is a small crack, leading to a canal, called the aqueductus vestibuli.

The inferior, or basilar portion looks downward and presents nine points: 1st. Near the centre a large round aperture, the carotid aperture of entrance. 2d. Internal to the carotid aperture is a rough quadrilateral surface extending to the apex of the bone. 3d. Behind the carotid aperture is a deep depression, the jugular fossa. 4th. Behind and external to the jugular fossa is an articular surface, the jugular facet, for articulation with the jugular eminence of the occipital. 5th. Near the posterior border, behind and slightly internal to the carotid aperture, and directly beneath the internal auditory meatus, is a small opening, the aqueductus cochleæ. 6th. Passing downward, from a point about midway between the mastoid process and the carotid aperture, is a long tapering process, varying in size and direction, and called

the styloid process; it is formed from a separate ossific centre and does not become ossified to the rest of the bone until after puberty; it is usually directed downward, forward and inward and connected by a ligament with the hyoid bone. 7th. Embracing the base of the styloid process and extending from the auditory process, with which it is continuous, to the carotid aperture, is a narrow prominence, called vaginal process. 8th. Behind the base of the Styloid process, and between it and the mastoid process, is a small opening, called the stylo-mastoid foramen. 9th. Between that portion of the auditory process, which is continuous with the vaginal process, and the mastoid process is a slight fissure, the auricular fissure.

The anterior face looks forward and upward and presents five points: 1st. About the centre is the bulge of the superior semicircular canal. 2d. External to this is a depression, corresponding to the tympanum. 3d. Below the bulge is a groove leading to the hiatus Fallopii. 4th. External to this is a small groove, the petrosal, often not seen. 5th. Near the apex is a depression, called the digital pit for the Casserian ganglion.

The base of the petrous portion is partly interposed between the other two portions and partly continuous with them. On the free portion is seen the opening into the ear, the external auditory meatus, which is situated between the mastoid process behind and the middle root of the zygoma in front, and between the posterior root of the zygoma above and the auditory process below. The auditory process is a rough curved sheet of bone continuous with the vaginal process, and partly circumscribing the external auditory meatus.

The apex of the petrous portion is rough and presents a large irregular aperture for the carotid artery. It is received between the basilar process of the occipital bone and the spinous process of the sphenoid.

The borders are three, superior, posterior and anterior. The superior is slightly grooved for the petrosal sinus and notched near the apex by the fifth nerve.

The posterior border is interrupted about its centre by a projecting triangular piece of bone which partially subdivides the jugular fossa. This border articulates with the occipital bone.

The anterior border is the shortest, and where it is lost on the internal surface of the squamous portion, the remains of a suture are discernible. In the retreating angle formed between this border and the squamous portion are seen two small apertures separated by a thin plate of bone, called processus cochleariformis; the upper aperture is for the tensor tympani muscle, the lower for the Eustachian tube. From the point

where this border joins the squamous portion, it is free, separated from the spinous process of the sphenoid by a slight interval.

SUMMARY.

Squamous Portion—Front, upper, thin, semicircular:

External Surface—Bulge, arterial grooves, temporal ridge, zygomatic process, first directed outward, then twisted and runs forward; concave internally, convex externally, upper border thin, lower thick and arched, bevelled and serrated at anterior extremity. Rises by two roots; anterior is eminentia articularis; posterior divides into two branches, upper lost in temporal ridge, lower turns downward to fissure of Glasser, tubercle at junction of the two roots.

The Glenoid Fossa lies between the two roots of the zygoma from the eminentia articularis to the vaginal process, is crossed by fissure of Glasser and is smooth in front and rough behind.

Internal Surface—Pitted, furrowed and concave.

Superior Border—Semicircular, beveled, articulates with parietal bone above and greater wing of sphenoid in front.

Mastoid Portion—External Surface—Rough, convex, mastoid foramen and process; digastric fossa; occipital furrow.

Internal Surface—Fossa sigmoidea.

Upper Border—Articulates with posterior inferior angle of parietal.

Posterior Border—Articulates with occipital.

Petrous Portion—Internal, intermediate, oblique, triangular and tapering.

Anterior Face—Roof of middle ear, bulge of semicircular canal, hiatus Fallopii, petrosal groove, digital pit.

Posterior Face—Internal auditory meatus; aqueductus vestibuli.

Basilar Face—Auricular fissure, stylo-mastoid foramen, styloid process, vaginal process, jugular fossa, jugular facet, carotid aperture, aqueduct of cochlea, rough surface.

Superior Border—Faintly grooved.

Posterior Border—Interrupted about centre by triangular tongue of bone.

Anterior Border—Short; aperture of tensor tympani above, processus cochleariformis, and below it Eustachian aperture.

Base—External auditory meatus and auditory process.

Apex—Carotid aperture.

Sphenoid Bone.

The sphenoid is found in the centre of the base of the cranium, ar-

ticulating with all the other cranial bones and with five of those of the face. It is divided, for description, into a body two greater and two lesser wings and two pterygoid processes, and is said to resemble a bat with its wings spread out.

The body is the central portion of the bone, from which the other portions spring. It presents six surfaces, superior, inferior, anterior and posterior and two lateral.

The superior, or cerebral face, has projecting forward a thin triangular process called the ethmoidal spine, for it is received into the sphenoidal notch of the ethmoid. Passing backward from this on the middle line is a slight ridge, on either side of which the surface is slightly depressed; at the posterior termination of the ridge is a transverse groove, the optic, terminating at each extremity in an opening, the optic foramen, just behind the optic groove, the surface is raised into a transversely oblong elevation, the olivary process or ridge, which usually presents at either side a tubercle called the middle clinoid process; behind the olivary ridge the surface is deeply sunken, and the depression is called the Sella Turcica; on either side of the Sella Turcica is a broad curved groove, the cavernous or carotid groove, behind the Sella Turcica, the surface is quadrilateral, slopes downward and backward and is called the dorsum ephippii, which terminates in front at either side in a projection, overhanging the Sella Turcica, called the posterior clinoid process.

The inferior surface presents a central longitudinal projection, the rostrum, on either side of which is a thin plate of bone, the vaginal process, towards the outer part of which, visible from below, is a groove, the pterygo-palatine.

The anterior surface shows a central projection passing from the ethmoidal spine to the rostrum, called the beak; on each side of this is seen the irregular opening into the cavity into which the body is hollowed; this cavity is divided by a medium septum.

The posterior surface is rough, vertical, quadrilateral and articular for the extremity of the basilar process of the occipital bone, to which it becomes ossified early in life.

Each lateral portion of the sphenoid bone consists of two parts called greater and lesser wings, both springing from the side of the body and are separated by an irregular triangular interval, the sphenoidal fissure, or in the articulated skull, foramen lacerum anterius.

The lesser wing projects outward from the front upper part of the side of the body and is triangular in shape, having its base internal and perforated by the optic foramen. Its anterior border is comparatively straight and serrated for articulation with the orbital plate of the frontal

bone. Its posterior border is free and terminates internally in a projection called anterior clinoid process. The upper and lower surfaces of the lesser wing are flat.

The greater wing comprises the greater part of each lateral portion of the bone, extending outward from the side of the body, it springs from it by a narrow portion called the pedicle. It presents four surfaces, superior, inferior, anterior and external.

The superior or cerebral surface is smoothly concave and has on it three foramina in an antero-posterior row, situated a little external to the pedicle; they are known, from before backward as rotundum, ovale and spinosum. Rotundum opens in orbit and ovale and spinous below. The first two are of considerable size and derive their names from their shape, the last is small and derives its name from its situation in a rough process, which projects downward from the greater wing, called the spinous process.

The anterior, or orbital surface is flat, smooth and quadrilateral, forming part of the outer wall of the orbit. It is bounded above by a serrated border for the frontal bone, below by a rounded border for the spheno-maxillary fissure, externally its border is serrated for the malar bone.

The external surface consists of two parts—a vertical portion, which enters into the temporal fossa, and a horizontal portion, which is the inferior face, and aids in forming the zygomatic fossa; between these is a ridge called the pterygoid, which terminates anteriorly in a triangular spine. Opening on the inferior face are the foramina ovale and spinosum.

The pterygoid process stands downward on each side from the union of the body and greater wing. It consists of an inner and outer plate meeting in front at an acute angle, thus exhibiting between them, posteriorly, a depression called the pterygoid fossa; the external plate is the shorter and much the broader; the internal plate is narrow, and terminates below in a hook-like projection called the hamular process. Tracing up the posterior aspect of the internal plate, there is seen to commence, about or a little above its centre, an oblong depression called the scaphoid fossa. Piercing the base of the pterygoid process is a foramen, called the pterygoid or Vidian. At the front of the base of the process, extending upward, is a flat surface, forming the posterior wall of the spheno-maxillary fossa, upon which are seen the openings of two foramina—the pterygoid and rotundum—and a groove called the pterygo-palatine notch. The inner aspect of the internal plate is the outer boundary of the posterior opening of the nose. The two plates are sep-

arated below by an angular interval, which is filled by the tuberosity of the palate bone.

SUMMARY.

Parts—Body—Two lesser and two greater wings; two pterygoid processes.

Situation—Base and centre of the cranium.

Body—Upper Surface—Ethmoidal spine; central ridge; lateral depression; optic groove; optic foramen; olivary ridge; middle clinoid processes; sella Turcica; cavernous groove; dorsum ephippii; posterior clinoid processes.

Lower Surface—Rostrum; two vaginal processes; two pterygo-palatine grooves.

Anterior Surface—Median septum and lateral cells

Posterior Surface—Articular, rough and quadrilateral.

Lesser Wing—Triangular; base pierced by optic foramen; surface above and below flat; front edge straight and serrated; posterior edge smooth and concave, terminating internally in anterior clinoid process. The space between the greater and lesser wings is the sphenoidal fissure, or foramen lacerum anterius.

Greater Wing—Arises by pedicle from side of the body. Upper or cerebral surface, concave; three foramina—rotundum, ovale, spinosum. Anterior face; quadrilateral, flat and smooth, and enters into outer wall of orbit. Outer face; temporal fossa; zygomatic fossa, separated by pterygoid ridge, which terminates anteriorly in a spine. Greater wing terminates behind in spinous process.

Pterygoid Process—Outer plate broader and shorter.

Inner plate—long and narrow, hamular process and scaphoid fossa.

Pterygoid foramen, pterygoid fossa.

Flattened surface above the process anteriorly, upon which are pterygo-palatine notch and foramina rotundum and pterygoid.

Ethmoid Bone.

The ethmoid bone is in the middle of the front of the base of the cranium and consists of a body and two lateral masses.

The body is partially seen by looking from above on the base of the cranium, for it lies in the ethmoidal notch of the frontal bone.

The superior surface of the body is called the horizontal, or cribriform plate, being perforated by numerous small foramina; these foramina are said to be arranged in three rows on each side of the middle line, extending from before backwards; the outer and inner rows are much more distinct

than the middle, the foramina of which are small and irregular. These foramina are on a depressed surface, which is separated from the opposite one by a projection called the crista Galli, which extends upward from the superior surface; it commences toward the rear part of the surface and gradually rises in height towards the front; it is sometimes hollow with bulging sides, and it varies greatly in height and size. Projecting outward from the front of it are two small processes, one towards each side, called the alar processes. At each side of the base of the crista Galli is a small fissure called the nasal groove, or slit. Posteriorly the superior surface presents a deep notch, the sphenoidal fissure, for the reception of the ethmoidal spine of the sphenoid bone.

Laterally this surface articulates with the orbital plate of the frontal bone; anteriorly with the frontal bone by the two alar processes which complete, posteriorly, an opening called the foramen coecum.

From the lower surface of the cribriform plate there passes downward, on the middle line, a thin sheet of bone called the perpendicular lamella, which aids in forming the septum of the nose, articulating in front with the nasal spine of the frontal and with the nasal bones; posteriorly it articulates above with the beak of the sphenoid, below with the vomer; inferiorly it gives attachment to the cartilage of the septum. Its faces are grooved.

The lateral mass lies to the side of the perpendicular lamella, with a slight interval between; it presents an outer, inner and superior face. The outer surface forms part of the inner wall of the orbit; it is smooth, flat and quadrilateral and is called the osplanum; its upper part is perforated by two canals, which are the anterior and posterior ethmoidal foramina. The internal surface is convex, rough and fissured behind; this fissure is called the superior meatus of the nose; above this a curved portion of the bone called the superior turbinated bone; below the superior meatus is another portion called the middle turbinated bone, which is the upper limit of the middle meatus of the nose. The superior surface of the lateral mass presents numerous irregular openings into the cells, of which this part of the bone is made up; these are closed in by the overlapping horizontal plate. Projecting downward and backward from the lower edge of the lateral mass is a thin plate of bone called the unciform process, which articulates with the ethmoidal process of the inferior turbinated and helps to close the opening of the antrum maxillare. From the posterior extremity of the lateral mass there projects backward a triangular, curled pointed process, which extends into the sphenoidal cell of that side, and, as puberty approaches, becomes detached from the ethmoid and ossified to the sphenoid; it is called the sphenoidal spongy

bone, or pyramid of Wistar. The cells, of which the lateral mass consists, are separated by a transverse septum into two sets, the anterior and posterior ethmoidal cells; the anterior communicate with the middle meatus by a tortuous canal called the infundibulum, with which the frontal sinus also communicates; the infundibulum opens into the upper front part of the middle meatus by a large orifice. At the upper back part of the superior meatus is an orifice which leads into the posterior ethmoidal cells.

SUMMARY.

Situation—Middle of front of the base of the cranium.

Parts—Body and two lateral masses.

Body—Superior Surface—Cribiform plate; crista Galli in centre; alar processes; nasal groove; depression on each side, with three rows of foramina; sphenoidal notch.

Inferior Surface—Perpendicular lamella.

Lateral Mass—Outer Surface—Osplanum, smooth, flat, quadrilateral.

Internal Surface—Convex, rough; superior turbinated bone; superior meatus; middle turbinated bone; unciform process.

Superior Surface—Cellular; two canals; anterior and posterior ethmoidal foramina.

The Bones of the Face.

The bones of the face are fourteen, as follows: Two nasal, two lachrymal, two malar, two superior maxillary, two palate, two inferior turbinated, one vomer, one inferior maxillary.

Nasal Bones.

The nasal bones are two small, flat bones, forming the bridge of the nose, along the centre of which they articulate with each other. Each bone is quadrilateral, presenting two surfaces, two extremities and two borders.

The upper extremity articulates with the nasal notch of the frontal bone; it is thicker and narrower than the lower, which latter presents a notch.

The anterior surface is broad and convex toward its lower part, while its upper part is narrow and concave; this surface presents a foramen.

The posterior face has on it a vertical furrow for the nasal nerve.

The internal border is the shorter and when articulated with its fellow, presents a crest, for articulation with the nasal spine of the frontal, and the perpendicular lamella of the ethmoid.

The external border articulates with the nasal process of the superior maxillary bone.

Lachrymal Bone.

The lachrymal bones are a pair of small bones, one being found on the inner wall of each orbit in front of the os planum. The bone remotely resembles a finger nail and hence acquires its synonym of unguis. It presents two faces, two extremities and two borders. The external face is divided into an anterior and a posterior portion, by a vertical ridge, which terminates inferiorly in a hook-like process called hamular. The posterior and larger portion is part of the inner wall of the orbit and is flat and smooth. The anterior portion is a vertical groove, called the lachrymal.

The internal face is rough for articulation with the ethmoid bone, and presents a vertical groove corresponding to the vertical ridge on the opposite side; the portion of the surface in front of this groove enters into the formation of the middle meatus.

The upper extremity articulates with the internal angular process of the frontal bone.

The lower extremity is divided into two parts, the posterior articulating with the orbital plate of the superior maxillary, the anterior projecting farther downward and articulating with the lachrymal process of the inferior turbinated. The anterior border articulates with the nasal process of the superior maxillary bone.

The posterior border articulates with the os planum.

Inferior Turbinated Bone.

The inferior turbinated, or inferior spongy bone, is found on the lower part of the outer wall of the nasal fossa; the middle and superior turbinated bones are merely parts of the ethmoid. The bone is divisible into two extremities, two faces and two borders.

The anterior extremity is much the larger and articulates with the inferior turbinated crest of the superior maxillary.

The posterior extremity is slender and pointed and articulates with the inferior turbinated crest of the palate bone.

The internal face is convex and marked by apertures and grooves.

The external face is concave and enters into the inferior meatus of the nose.

The inferior border is rounded and free, marking the limit between the middle and inferior meatus.

The superior border articulates from before backward with the superior maxillary, the lachrymal, the ethmoid and the palate bones. It presents three processes, lachrymal, ethmoid and maxillary. The lachrymal

process is directed upward to articulate with the lower extremity of the lachrymal bone, and with the nasal process of the superior maxillary, aiding to form the lachrymal canal.

The maxillary process is larger than the other two and is a curved plate of bone directed downward and outward from the base of the ethmoidal process and articulates with the superior maxillary by hooking around the orifice of the antrum. The ethmoidal process is behind the lachrymal, and is directed upward to articulate with the unciform process of the ethmoid.

Vomer.

The vomer is a single bone found separating the nostrils behind and below, forming part of the septum of the nose; the upper part of the septum is the perpendicular lamella of the ethmoid; the anterior part is a plate of cartilage. It presents two faces and four borders.

The faces are lateral and each forms part of the inner wall of a nostril, the bone usually bulging toward one or the other. They are marked by shallow furrows and by the naso-palatine groove, which is directed obliquely downward and forward on each face.

The superior border presents an antero-posterior groove which receives the rostrum of the sphenoid bone; the edges of the groove are projected outward into lips, or alæ, each of which lies in the groove above the vaginal process of the sphenoid bone.

The inferior border is received between the everted edges of the palate processes of the superior maxillary bones and of the horizontal plates of the palate bones.

The anterior border presents a longitudinal fissure which receives superiorly the perpendicular lamella of the ethmoid, inferiorly the triangular cartilage of the septum; the lower part is occasionally not fissured but rough.

The posterior border is concave and free, terminating, posteriorly, the septum of the nose.

Malar Bone.

The malar bone forms the prominence of the cheek, is somewhat quadrangular and presents for examination four processes and a body with two surfaces and four borders.

The anterior, or external face is convex and has several foramina opening on it, called malar.

The posterior, or internal face is smooth and concave, entering into the temporal fossa above and the zygomatic below.

The frontal process projects upward to articulate with the external angular process of the frontal bone.

The orbital process is a smooth projecting lip of bone curving downward from the frontal process, and projecting inward, forming a concavity which enters into the outer wall and floor of the orbit. Its lower surface forms part of the temporal fossa. Superiorly it articulates with the frontal bone. Posteriorly it articulates with the sphenoid bone; internal to which it articulates with the orbital plate of the superior maxillary bone; between these two articulations there is often seen the narrow, rounded, non-articular anterior extremity of the spheno-maxillary fissure. This process presents the openings into one or more small canals, temporo-malar, which extend to the anterior surface of the bone and some usually to the posterior surface.

The maxillary process is rough and triangular, articulating with the superior maxilla.

The zygomatic process stands backwards, is long and narrow and articular with the zygomatic process of the temporal.

The superior border is concave, smooth and rounded, and forms part of the margin of the orbit.

The inferior border is straight and continuous with the lower edge of the zygoma.

The anterior border is straight and rough to articulate with the superior maxilla.

The posterior border is sinuous and continuous with the temporal ridge above, and below with the upper edge of the zygoma.

Superior Maxillary.

The superior maxillary bones form the upper jaw and are, with the exception of the inferior maxillary, the largest bones of the face. Each bone articulates with the frontal and ethmoid, and all the bones of the face except the inferior maxillary. The bone is divisible into a body and four processes.

The body is irregularly quadrilateral, is hollowed out into a cavity called the antrum of Highmore, or antrum maxillare, and presents four faces—anterior, superior, posterior, internal.

The anterior or facial surface is somewhat concave and presents about its centre a depression, called the canine fossa, which is limited internally by a vertical ridge, the canine ridge; on the inner side of the canine ridge is another depression, the incisive fossa; just above the canine fossa is a foramen, the infra-orbital. This surface is limited internally by the thin concave edge of the nasal fossa; below by the alveolar process; ex-

ternally by the malar process and a ridge descending from it; superiorly by the margin of the orbit.

The posterior or zygomatic surface is chiefly occupied by a rough bulge, the tuberosity of the superior maxillary bone; it presents numerous small foramina, and at its lower part a rough oval surface; above and internal to this is a smooth spiral groove, which, with a similar groove on the palate bone, forms the posterior palatine canal. The upper limit of this surface, separating it from the orbital face, is a smooth rounded border, on which is a notch, the commencement of the infra orbital canal. The malar process separates this face from the anterior; below it is limited by the alveolar process.

The superior or orbital surface forms the floor of the orbit. It is formed of a thin triangular plate of bone, is smooth, sloping downward and forward, and marked from behind forward by a groove, the infra-orbital canal, which disappears in the bone to terminate at the infra-orbital foramen on the anterior face. This face is bounded internally by a rough edge for articulation, from behind forward, with the palate, ethmoid, and lachrymal bones; anteriorly it is limited by the lower margin of the orbit, internally, and, externally, by a rough border for articulation with the malar bone; externally it is separated from the posterior surface by a rounded border on which begins the infra-orbital canal by a notch; this border forming, in the articulated skull, the lower margin of a fissure, the spheno-maxillary.

The internal or nasal surface aids in forming the outer wall of the nose, and presents a large irregular aperture leading into the antrum of Highmore; this aperture is much reduced by articulations with neighboring bones, palate, ethmoid, lachrymal and inferior turbinated. The antrum is indistinctly triangular; in it are seen numerous vertical grooves and on its floor several conical projections which mark the position of molar teeth. In front of the opening into the antrum is a deep vertical groove, the sulcus lachrymalis. This face is limited above by the nasal process, in front, and behind this by a rough cellular edge for articulation with the lachrymal and ethmoid bones; inferiorly is the horizontal palate process, which may be said to divide it into two portions, the part below terminating in the alveolar process and the part above forming the inferior meatus of the nose. The posterior border is rough for articulation with the palate bone. The anterior edge is sharp and concave and forms the margin of the anterior nares.

The four processes are nasal, malar, palate and alveolar. The nasal process is a long, thin, triangular projection forming a part of the wall of the nose and presenting three borders and two surfaces.

The anterior border is convex, thin and serrated for articulation with the nasal bone.

The posterior border is thick and grooved; the posterior margin of the process is rough for articulation with the lachrymal bone; the anterior margin is rounded, continued into the margin of the orbit, and presents below a small tubercle. This groove, in the articulated skull, is formed into a canal for lodging the nasal duct, and is nearly vertical, being slightly oblique backward and outward. The upper border is blunt and serrated for articulation with the frontal bone, its internal angular process.

The external face is concave and marked by small foramina.

The internal face is crossed from behind forward by two rough ridges, crista turbinalis inferior and superior, the former articulating with the inferior turbinated and the latter with the ethmoid. Above the superior turbinated crest the surface is rough for articulation with the ethmoid; between the two crests it is smooth and concave, entering into the middle meatus of the nose.

The malar process forms the upper part of the boundary between the anterior and posterior faces. It is concave both in front and behind, triangular in outline and its summit is rough for articulation with the malar bone.

The palate process projects inward from the lower part of the internal surface, forming a portion of the floor of the nose and the roof of the mouth. It does not extend as far back as the body of the bone, but may be said to be deficient behind. Its upper surface is transversely concave and smooth. In front is a foramen which leads into the anterior palatine canal, which appears on the inner border of the process as a groove. Its lower surface is also concave, but rough, marked by numerous shallow depressions and by a groove externally, which runs from behind forward. The inner border is rough, to articulate with its fellow on the opposite side; it is thicker anteriorly than posteriorly, and its upper edge is raised into a ridge, or crest, which is slightly everted, so as to produce, when the bone is articulated, a narrow groove, for the reception of the vomer. Towards the front the inner border, in its lower part, presents a groove, which sinks into the bone above to communicate with a foramen on the upper surface, the anterior palatine. In front the inner border terminates in a slender, pointed process, which, united with a similar one on the opposite bone, forms the anterior nasal spine.

The anterior border of the process is the thin concave margin of the nose, the nasal notch.

The posterior border is straight and serrated for articulation with the horizontal plate of the palate bone.

The alveolar process projects downwards from the lower, outer part of the bone, and forms about a fourth of the circumference of a circle. It is marked by sockets for eight teeth, with intervening septa.

SUMMARY.

Body and four processes.

Body—Quadrilateral and hollow, antrum of Highmore.

Anterior Face—Concave; canine fossa; canine ridge; incisive fossa; infra-orbital foramen.

Posterior Face—Tuberosity; rough oval surface; palatine groove.

Superior Face—Triangular, flat, smooth, sloping; groove.

Internal Face—Opening into antrum, which is triangular, has vertical grooves and projections for roots of molar teeth; sulcus lachrymalis.

Nasal Process—Long, thin; anterior border convex; posterior, deeply grooved. Outer face concave; inner two transverse ridges; crista turbinalis inferior and superior; between them a concavity. Upper extremity blunt and serrated.

Malar Process—Triangular, short, large and rough.

Palate Process—Projects inward from inner surface; defective posteriorly; upper face concave and smooth; lower face concave and rough, with antero-posterior groove. Inner border rough; crest: thickest in front; grooved; nasal spine and notch.

Alveolar Process—Projects downwards; forms one-fourth of circle sockets for teeth.

Palate Bone.

The palate bone enters into the formation of the orbits, the nasal fossæ and the roof of the mouth. It is divided into horizontal and vertical, or perpendicular portions, or plates.

The horizontal portion projects inward, at about a right angle, from the lower limit of the vertical plate, and presents two surfaces and three borders. The superior or nasal face is smooth and concave transversely, forming the back part of the floor of the nose. The inferior face is also slightly concave transversely and rough, forming the posterior part of the hard palate. A transverse ridge crosses it posteriorly The anterior border is serrated for articulation with the palate process of the superior maxillary.

The posterior border is smooth, concave and free, having its inner extremity prolonged backwards by a slender, sharp process, which with a

similar projection on the opposite bone, forms the posterior nasal, or palate spine. The internal border is thick, rough and serrated for articulation with its fellow; the upper edge of this border is raised and produces, when articulated, a slight groove for the reception of the vomer.

The *vertical plate* is irregularly quadrangular and presents two faces, internal and external, and three borders, superior, anterior and posterior. The internal surface presents two transverse ridges, the superior and inferior turbinated crests; the inferior to articulate with the inferior turbinated bone, and the superior with the middle turbinated bone of the ethmoid. This surface, below the inferior turbinated crest, is concave and forms the outer boundary of the inferior meatus of the nose; the surface between the two crests is also concave, and forms a part of the middle meatus; above the superior crest is a narrow groove.

The external surface is, to a great extent, rough for articulation with the internal face of the superior maxilla; but at its upper, back part there is a smooth portion, which forms a part of the spheno-maxillary fossa. At the posterior part of this face is a vertical groove, converted into the posterior palatine canal by articulation with the tuberosity of the superior maxilla.

The superior border presents two processes, separated by a deep notch. The notch is called spheno-palatine, and is converted into a foramen of that name by the articulation of the sphenoid bone. The anterior process is known as the orbital; the posterior as the sphenoidal. The orbital process inclines outward as it ascends, is hollow and higher than the sphenoidal, being perched upon a thin plate of bone, its neck. It presents five faces—anterior, posterior, internal, external and superior—the first three being articular, the others non-articular.

The anterior face articulates with the orbital surface of the superior maxillary.

The posterior face articulates with the sphenoid bone.

The internal face articulates with the ethmoid bone and usually presents the opening into the cellular cavity in the process; but this is sometimes on the posterior face.

The external face forms a part of the inner wall of the spheno-maxillary fossa.

The superior face forms the back part of the floor of the orbit.

The sphenoidal process is a thin plate of bone, inclining inward as it ascends, and presents three faces—superior, external and internal—and two borders—anterior and posterior.

The superior face articulates with the sphenoid bone and presents a groove, converted, by articulation, into the pterygo-palatine canal.

The external face partly enters into the formation of the spheno-maxillary fossa, and partly articulates with the pterygoid process of the sphenoid.

The internal face is free and forms part of the outer wall of the nasal fossa.

The anterior border of the process is the posterior boundary of the spheno-palatine notch.

The posterior border of the process articulates with the pterygoid process of the sphenoid bone.

The anterior border of the perpendicular plate is irregular, articulates with the superior maxillary bone and presents, at the intersection of the inferior turbinated crest, a thin process, the maxillary, which aids in closing the opening into the antrum maxillare.

The posterior border of the perpendicular plate is grooved and articulates with the pterygoid process of the sphenoid. At its lower part is a process, the pterygoid process, or tuberosity of the palate bone. It is triangular, is directed downward and backward and outward, and fits into the interval between the two plates of the pterygoid process of the sphenoid. Descending the middle of the tuberosity, posteriorly, is a smooth groove, which, when the bone is articulated, forms part of the pterygoid fossa; on each side of this groove is a rough groove, which articulates with the corresponding plate of the pterygoid process of the sphenoid. Externally the tuberosity is rough and articulates with the superior maxilla. The openings of numerous canals, the accessory posterior palatine canals, are seen on the tuberosity, and it is perforated vertically through its base by the posterior palatine canal.

SUMMARY.

Horizontal and vertical portions.

Horizontal portion—Upper or nasal surface, concave and smooth; lower, roof of mouth; concave, rough, transverse ridge, externally a groove. Anterior border serrated and articular. Internal border also rough and articular. Posterior border, smoothly concave and free; posterior nasal or palatine spine.

Vertical Portion—Inner Surface; superior and inferior turbinated crests, concave space between.

Outer Surface—at back part, vertical groove, post-palatine canal. Upper Border; orbital and sphenoidal processes, with spheno-palatine notch between.

Orbital Process—Anterior face articulates with superior maxillary.

Posterior face articulates with sphenoid.

Internal face articulates with ethmoid.

Superior face free and orbital.

Outer face enters into spheno-maxillary fossa.

Sphenoidal Process—Superior face articulates with sphenoid.

Inner face free and nasal.

Outer face partly enters spheno-maxillary fossa and partly articular for pterygoid process.

Anterior border of vertical plate, irregular, articular for superior maxillary, maxillary process.

Posterior border of vertical plate, grooved, articular for pterygoid process, terminates below in tuberosity.

Tuberosity, triangular, projects downward, backward and outward, behind has shallow smooth groove, with rough groove on each side; externally, rough.

Inferior Maxillary Bone.

The inferior maxilla, or lower jaw bone, is a single bone forming the lower jaw. It consists of a horizontal portion, the body and a vertical portion, the ramus, on each side.

The body is semicircular of a horse-shoe shape, and presents an external and an internal surface and two borders.

The external surface is convex from side to side, concave from above downward. In front, on the middle line, is a vertical ridge, the symphysis menti or crista mentalis; this spreads out as it descends, forming a triangular projection, the mental process, which produces the prominence of the chin. External to the symphysis is a depression, the incisive fossa, and still farther out is a foramen, the mental. Extending upward and backward from the mental foramen is an indistinct ridge terminating in the anterior border of the ramus, and called the external oblique ridge.

The posterior surface is concave transversely, and presents in front four projections called spinae mentales, or genial tubercles, superior and inferior; they are situated two on each side of the middle line, one above the other, but frequently coalescing to form one. External to the genial tubercles is a slight depression, for the sublingual gland; and below this another small depression, the digastric fossa. Extending upward and backward from the digastric fossa is a ridge, the internal oblique, or mylo-hyoid ridge, below the posterior half of which is a depression, the sub-maxillary fossa.

The upper border is the alveolar process and presents the sockets for sixteen teeth with intervening septa. The lower, or basilar border is rounded, smooth and generally protuberant. It may be marked about where it joins the ramus by a slight groove for the facial artery.

The ramus is a quadrilateral plate which projects more or less obliquely upward from each posterior extremity of the body. It is divided into two surfaces and four borders.

The external face is rough and ridged for muscular attachment.

The internal face presents a large foramen, the inferior dental, bounded below by a sharp lip of bone; extending downward and forward from the foramen is a groove, the mylo-hyoidean. The foramen is the opening of the inferior dental canal, which extends downward and forward through the ramus and then forward through the body, beneath the alveoli, with each of which it communicates; from near the symphysis it recedes to the mental foramen.

The anterior border is grooved, the outer lip of the groove being continuous with the external oblique ridge.

The posterior border is more or less oblique and rounded.

The lower border, continuous with the basilar border of the body, is straight. At the junction of the lower and posterior border is situated the angle of the lower jaw, which is rough and everted.

The superior border presents two projections, separated by a deep notch called the sigmoid notch. The projection in front of the notch is the coronoid process; that behind, the condyle.

The coronoid process is thin and triangular.

The condyle of the lower jaw consists of a convex, oval, articular surface, mounted upon a constricted portion called the neck. The long diameter of the condyle is oblique, extending from without inward and backward. The articular surface, which plays in the glenoid fossa of the temporal bone, extends farther down posteriorly than anteriorly. The neck of the condyle is constricted antero-posteriorly, is buttressed by ridges and marked externally by a small tubercle, internally by a depression.

As life advances from the adult period, the obliquity with which the ramus ascends increases, so that in extreme old age it almost prolongs the direction of the body. In early life the angle between the ramus and the body is also great, but it decreases gradually up to middle life, when it is nearly a right angle. When the teeth have been for sometime lost the alveolar process wastes and finally disappears, so that the upper border of the body may correspond with the external oblique ridge.

SUMMARY.

Horizontal portion, or body and vertical portion, or rami.

Body—Anterior surface; convex transversely, concave vertically; crista

mentalis; mental process, incisive fossa, mental foramen, external oblique ridge.

Posterior Surface—concave transversley, superior and inferior spinæ mentales or genial tubercles, sublingual fossa, digastric fossa, internal oblique or mylo-hyoidean ridge, sub-maxillary fossa.

Superior Border—alveolar, sockets for sixteen teeth with septa between.

Inferior Border—basilar, rounded, protuberant, groove for facial artery.

Ramus—Outer Surface—ridged.

Inner Surface—inferior dental foramen of inferior dental canal, which traverses body and ramus, and terminates at mental foramen. Sharp lip and spine below foramen, mylo-hyoidean groove.

Anterior Border—grooved.

Posterior Border—more or less oblique.

Inferior Border—straight; at junction with posterior border is the angle of the inferior maxilla, which is rough and everted.

Superior Border—coronoid process, sigmoid notch, condyle.

Condyle—articular, convex, oval, long diameter from without inward and backward; neck is thin and flattened from before backward, and has fossa internally.

The Articulated Skull.

The articulated skull is produced by the union of the bones of the cranium and the bones of the face. A description of the articulations, known as sutures, will be found under the head of articulations in general.

The skull is divisible into five regions: superior, inferior, anterior and two lateral.

Superior Region.

The superior region, or vertex, is bounded in front by the frontal eminences, on each side by the temporal ridge, and behind by the posterior occipital protuberance and the superior curved lines of the occipital bone. It is formed by part of the frontal bone, most of the parietal bones and a part of the occipital bone. It is divided into a superior and an inferior aspect.

The superior surface is seen to be crossed transversely by the coronal suture, extending backward from the centre of which is the sagittal suture, which terminates posteriorly in the lambdoid suture. The parietal foramen may be seen on each side of the sagittal suture near its posterior extremity. On each side is seen the parietal eminence. This surface is markedly convex.

The inferior, or cerebral surface, is concave, and presents the following appearances: on the frontal bone, in the middle line, is seen the indistinct commencement of a groove, for the superior longitudinal sinus, which passes backward, growing broader and more distinct as it travels, first along the line of union of the parietal bones and then down the superior limb of the occipital cross to terminate at the anterior occipital protuberance; along the edges of this groove are seen several pits for lodging the Pacchionian bodies, and external to these the digital pits for the convolutions of the brain; numerous arborescent arterial furrows are also seen.

Lateral Region.

The lateral region is subdivided into four portions—mastoid, temporal, zygomatic and spheno-maxillary.

Mastoid Portion.

The mastoid portion of the lateral region extends backward from the eminentia articularis, and in it are seen the following appearances: the mastoid foramen and process; the external auditory meatus; the auditory process, the glenoid fossa, which is bounded above by the posterior root of the zygoma, behind by the middle root and vaginal process, and in front by the anterior root of the zygoma. It is crossed transversely by the fissure of Glaser, the surface in front of the fissure being articular and that behind, rough; where the roots of the zygoma meet is the tubercle.

Temporal Portion.

The temporal portion of the lateral region is also called the temporal fossa. Its upper and posterior limit is the temporal ridge; this ridge commences at the external angular process of the frontal bone and curving upwards and backwards, leaves the frontal and passing across the parietal bone, arches downward over the squamous portion of the temporal bone and terminates in the posterior root of the zygoma. In front of the temporal fossa is the external angular process of the frontal bone and the malar bone. Below, it terminates at the zygoma without and the pterygoid ridge within. Its constituents are furnished by the frontal bone, the malar bone, the greater wing of the sphenoid the parietal bone and the squamous portion of the temporal bone.

Zygomatic Portion.

The zygomatic portion of the lateral region is situated below the temporal portion and is bounded above by the lower surface of the greater

wing of the sphenoid, the pterygoid ridge and the squamous portion of the temporal bone; in front, by the posterior surface of the superior maxilla and by the malar; internally, by the external pterygoid plate and pterygo-maxillary fissure; externally, by the zygoma and the ramus of the inferior maxilla. In this region are seen two fissures, one horizontal, the spheno-maxillary, and one vertical, the pterygo-maxillary, the one being at a right angle to the other. The spheno-maxillary fissure is seen by looking into the orbit; it is situated at the lower part of its outer wall posteriorly, between the greater wing of the sphenoid above and the orbital plate of the superior maxilla below, terminating, frequently, in the malar bone anteriorly; the posterior termination is at the point where the pterygo-maxillary fissure begins, which descends between the tuberosity of the superior maxillary in front and the pterygoid process behind.

Spheno-Maxillary Fossa.

At the point of junction of the two fissures is a small fossa, the size of the end of the little finger, called the spheno-maxillary fossa; it is thus formed: above is the flat surface just at the base of the pterygoid process anteriorly; behind is the pterygoid process; in front is the superior maxilla; internally is the perpendicular plate of the palate bone. There are five foramina found in this fossa. Three of them are found on the upper posterior wall, *i. e.*, on the flat surface at the base of the pterygoid process; they are—1st, foramen rotundum; 2d, pterygoid, or Vidian; 3d, pterygo-palatine; on the inner wall is seen the 4th, spheno-palatine; and 5th, inferiorly, is seen the opening into the posterior palatine canal, with accessory posterior palatine canals.

Taking the lateral region of the skull as a whole, it may be seen, from the foregoing description, that it is triangular in outline and is bounded as follows: the base is represented by the sweep of the temporal ridge; the apex is at the angle of the inferior maxilla; the sides may be represented by two lines, meeting at the angle of the inferior maxilla, the one drawn from the external angle of the frontal bone and the other from the mastoid process. The bones entering into its formation are: the mastoid and squamous, and the base of the petrous; portions of the temporal bone; part of the frontal bone; part of the greater wing of the sphenoid, part of the parietal, part of the malar, and the constituents of the spheno-maxillary fossa, as given above.

Inferior Region.

The inferior region, or base of the skull, presents two surfaces—superior, or cerebral, and inferior, or basilar.

The superior surface of the base of the skull is very uneven, supports the brain and is made of three depressions, lying one behind the other, and called anterior, middle and posterior fossæ.

The anterior fossa extends from the front wall of the cranium to the posterior border of the lesser wing of the sphenoid bone on each side and the olivary ridge in the centre. It is made up of the following bones: the orbital plates of the frontal; the cribriform plate of the ethmoid; the lesser wings and anterior portion of the body of the sphenoid. On either side the surface is somewhat convex from the bulging of the orbital plates; in the centre is the sunken surface of the cribriform plate, having in its centre the crista Galli, and on either side of this three rows of small foramina; in front of the crista Galli is the foramen coecum and, alongside its base, the nasal groove and slit. At the posterior termination of the fossa, in the centre, is the olivary ridge, terminating laterally, perhaps, in the middle clinoid processes, overhanging which are the anterior clinoid processes; in front of the olivary ridge are the optic groove and foramina.

The middle fossa is bounded in front by the posterior borders of the lesser wings of the sphenoid bone, laterally, and the olivary ridge in the centre; behind, by the upper border of the petrous portion of the temporal bone, on each side, and, in the centre, by the basilar suture. It is formed by the upper surface of the body and greater wings of the sphenoid, part of the squamous and the anterior surface of the petrous portion of the temporal bone. In the centre is seen the sella Turcica, on each side of which is a smooth, broad groove, the carotid or cavernous; more externally is an antero-posterior row of foramina, foramen lacerum anterius, (sphenoidal fissure), opening forward; foramen rotundum, also opening forward; foramen ovale, opening downward; foramen spinosum, opening downward; foramen lacerum medium. On the anterior face of the petrous portion of the temporal bone are seen the following points, from within outward: the digital pit, the groove leading to the hiatus Fallopii, the petrosal groove, the bulge of the superior semicircular canal, the depression corresponding to the tympanum.

The posterior fossa is bounded in front by the upper border of the petrous portion of the temporal bone, on each side, and in the centre by the basilar suture; posteriorly it is bounded by the horizontal limbs of the occipital cross and the anterior occipital protuberance. It is formed by part of the occipital, part of the body of the sphenoid, part of the parietal and the mastoid and posterior face of the petrous portions of the temporal. In the centre in front is the dorsum ephippii; behind this is the concave superior face of the basilar process; behind this is the

foramen magnum, on either side of which are the anterior condyloid foramina and the tubercles for the check ligament; behind the foramen magnum is the vertical limb of the occipital cross. On the posterior surface of the petrous portion of the temporal are seen the internal auditory meatus and the opening of the aqueduct of the vestibule. Just behind the petrous bone, and between its posterior border and the occipital bone, is the foramen lacrium posterius, or jugular foramen, which is usually partially subdivided by a spine projecting from the posterior border of the petrous bone. Arching inward to the jugular foramen is a broad, shallow groove for the lateral sinus; this groove begins at the anterior occipital protuberance and passes outward on each side, along the horizontal limb of the occipital cross, then curves downward over the posterior inferior angle of the parietal bone, and the mastoid portion of the temporal, and, regaining the occipital, reaches the jugular foramen.

Basilar Surface.

The basilar surface of the inferior region of the skull is formed by the palate processes of the superior maxillary and palate bones, the vomer, the pterygoid processes, body and greater wings of the sphenoid, the squamous, mastoid and petrous portions of the temporal and the occipital. It is bounded in front by the alveolar processes of the superior maxillary; behind, by the superior curved lines of the occipital and the posterior occipital protuberance; laterally by the lower border of the malar, the zygoma, and the mastoid process of the temporal. It presents in front the hard palate, which, when the skull is inverted for study, is considerably raised above the rest of the surface, and is bounded in front and laterally by the semicircular sweep of the alveolar processes. It is marked by crucial sutures, one extending along the middle line, between the palate processes of the superior maxillary bones and the horizontal plates of the palate bones; the other being transverse and uniting the palate processes of the superior maxillary and the horizontal plates of the palate bones. Near the front of the median suture, and just behind the incisor teeth, is a foramen, the anterior palatine, which passes between the nose and the mouth, and opens above by two apertures, one into each nasal fossa. On each side, near the rear of the palate, and just within the last molar tooth, is another foramen, the posterior palatine; running inward from this is a transverse ridge, and behind this is the free, concave, posterior border of the hard palate, which, in the centre, is prolonged backward into the palate, or posterior nasal spine; running forward from the posterior palatine foramen is a groove leading towards the anterior palatine foramen. Behind the hard palate is the

basilar process of the occipital bone, with its pharyngeal spine; behind this is the foramen magnum, on either side of which is the occipital condyle, extending out from which is the transverse ridge; in front of the condyle is the anterior condyloid foramen and, perhaps, the posterior behind it. Behind the foramen magnum is the occipital crest, leading up to the posterior occipital protuberance; diverging from about the centre of the crest are the inferior curved lines.

Returning to the hard palate, we see above it the posterior termination of the two nostrils, called the posterior nares; they are separated by the posterior concave border of the vomer and bounded, each, externally by the internal pterygoid plate, terminated below by its hamular process, having at its base the scaphoid fossa, and, between itself and the external plate, the pterygoid fossa. Near the base of the external pterygoid plate, a little behind and external, is seen the foramen ovale, and behind this the foramen spinosum; external, and posterior, to which are seen, in the receding angle between the squamous and petrous portions of the temporal bone, the two openings for the Eustachian tube and the tensor tympani muscle, separated by the processus cochleariformis. Near the base of the internal pterygoid plate is an irregular opening called the foramen lacerum medium, which is situated between the greater wing of the sphenoid, in front, the apex of the petrous bone, behind, and the body of the sphenoid and basilar process of the occipital, internally; on its anterior wall is the opening of the Vidian canal. Extending backward and outward is the inferior surface of the petrous bone, which presents the following points, from within outward: the rough surface, the carotid aperture, behind which is the jugular foramen, or the foramen lacerum posterius, situated between the posterior border of the petrous portion of the temporal and the jugular fossa of the occipital; continuing outward from the carotid aperture are the vaginal process, the stylo-mastoid foramen, the auricular fissure, the occipital groove and the digastric fossa.

Anterior Region, or Face.

The anterior region of the skull, or the face, is bounded above by the frontal eminences, below it is terminated by the mental process and basilar border of the inferior maxilla; laterally, it is limited by the malar bone. It is oval in outline, with its long diameter vertical and its broad end above. From above downward the appearances are as follows: below the frontal eminences are two transverse depressions; below these the superciliary ridges separated by the nasal tuberosity; supra-orbital ridges; supra-orbital notches or foramina; the bridge of the nose; the orbits; the anterior nares; anterior nasal spine; nasal notches, external

to each of which is the canine fossa, above which are the infra-orbital foramen and lower margin of the orbit; just below each nasal notch is the incisive fossa, external to which is the canine ridge; bounding the upper jaw, below, is the alveolar process of each side, with its teeth, and below the alveolar process and teeth of the inferior maxilla; next come the appearances met with on the front of the body of the inferior maxilla; in the centre the crest, terminating below in the mental process, on each side of it the incisive fossa, the mental foramen and the external oblique ridge. The bones that form the face, including the orbits and nasal fossæ, are three of the cranial bones, frontal, ethmoid and sphenoid, and all the facial bones.

The Orbits.

The orbits are two conical cavities, or excavations, situated on the upper part of the face and separated by the bridge of the nose and the ethmoid bone. Each orbit is conical in shape, its base being forward and its apex backward and inward, so that the long axis is oblique, and if the two were prolonged backward they would cross over the sella Turcica. The wall of the orbit is slightly flattened above, below and laterally, and is thus formed: the upper wall, or roof, is contributed principally by the orbital plate of the frontal bone, but is completed behind by the lesser wing of the sphenoid; the lower wall, or floor, is formed chiefly by the superior maxillary, completed antero-externally by the orbital process of the malar and posteriorly by the upper surface of the orbital process of the palate bone; the external wall is formed mainly by the greater wing of the sphenoid, but is completed anteriorly by the orbital process of the malar; the internal wall is formed principally by the os planum of the ethmoid, completed in front by the external face of the lachrymal and behind by the side of the body of the sphenoid. Nine openings communicate with the orbit, three entering posteriorly, three anteriorly, one externally and two internally. Posteriorly are, 1st, the optic foramen, found at the apex; 2d, the foramen lacerum anterius, at the upper back part of the outer wall; 3d, the spheno-maxillary fissure, at the lower limit of the outer wall. Anteriorly are, 1st, the supra-orbital notch, or foramen, at the inner third of the supra-orbital ridge; 2d, the infra-orbital foramen, about the centre of the lower margin; 3d, the opening of the nasal duct, at the inner angle, on the lachrymal bone, and formed by it and the nasal process of the superior maxillary. Externally, the temporo-malar, are several small foramina, seen on the outer wall, which communicate by canals with the anterior face of the malar bone and with the temporal fossa. Internally, 1st and 2d, anterior

and posterior ethmoidal foramina, situated in the upper part of the lateral mass of the ethmoid, and opening on the inner wall.

The Nasal Fossæ.

The nasal fossæ are two irregular cavities situated in the face and extending from the anterior to the posterior nares. The septum between the two is formed, above, by the perpendicular lamella of the ethmoid bone, in its lower posterior part, by the vomer and the angular interval left between the two, in front, is filled in by a triangular plate of fibro-cartilage, called the cartilage of the septum. Each fossa presents for examination four walls. The inner wall is formed by the septum. The the outer wall is formed by the superior maxilla, the inferior turbinated, the lachrymal, the ethmoid, the palate and the internal pterygoid plate of the sphenoid. The roof is formed by the nasal, the frontal, the ethmoid and the body of the sphenoid. The floor is formed, in front, by the palate process of the superior maxilla and completed behind by the horizontal plate of the palate bone. The outer wall of the nasal fossa is very uneven; a considerable bulge inward is produced, throughout its whole length, by the inferior turbinated bone, and the space between this bone and the floor is called the inferior meatus. Above the inferior is the middle turbinated bone, a part of the lateral mass of the ethmoid, and the space between these two is known as the middle meatus. In the upper part of the inner face of the lateral mass of the ethmoid, is a fissure called the superior meatus, situated between the superior and middle turbinated bones of the ethmoid. Opening into each fossa are eight apertures. Into the superior meatus there are three openings: 1st, the opening of the sphenoidal cells; 2d, the opening from the posterior ethmoidal cells; 3d, the *spheno palatine* foramen, communicating with the spheno-maxillary fossa. In the middle meatus there are also three openings: 1st, the the opening into the *antrum-maxillare;* 2d, the opening into the *anterior-ethmoidal* cells; 3d, the opening from the *frontal sinus*; the last two communicating with the upper front part of the meatus through the infundibulum. Into the inferior meatus there are two openings; 1st, the *nasal* duct, on its outer wall, and 2d, the *anterior palatine* foramen, on the floor. Just posterior to the outer wall of the inferior meatus is the opening of the *Eustachian tube.*

Articulations of the Bones of the Skull—

Occipital Bone.

The occipital bone articulates by its two condyles with the Atlas; by its superior border with the two parietal bones, forming the lambdoid

suture; by the outer half of each inferior border with the posterior border of the mastoid portion of the temporal bone, and by the inner half with the posterior border of the petrous portion; by the basilar process with the posterior surface of the body of the sphenoid bone, forming the basilar suture.

Parietal Bone.

The parietal bone articulates by its upper border with its fellow, forming the sagittal suture; by its lower border with the upper part of the semicircular border of the squamous portion of the temporal bone, forming the squamous suture; by its posterior border with the upper border of the occipital; by its anterior border, with one-half of the semicircular border of the frontal, forming one-half of the coronal suture; by its anterior, inferior angle, with the frontal triangle of the sphenoid, *i. e.*, the upper border of the outer surface of the greater wing of the sphenoid; by its posterior inferior angle, with the upper border of the mastoid portion of the temporal bone.

Frontal Bone.

The frontal bone articulates by its superior, or semicircular border with the anterior border of the two parietal bones; by the posterior border of each orbital plate with the lesser wing of the sphenoid; by the triangular surface *i. e.*, the sphenoidal triangle of the frontal, at the junction of the straight and semicircular borders, with the outer surface of the greater wing of the sphenoid; by the circumference of the ethmoidal fissure with the lateral and anterior borders of the cribriform plate of the ethmoid, and with the upper surface of the lateral mass of the ethmoid; by the nasal notch with the nasal bones and the nasal process of the superior maxillary; by the nasal spine with the crest of the nasal bones, in front, and with the upper part of the anterior border of the perpendicular lamella of the ethmoid, behind; by the internal angular process with the lachrymal bone; by the external angular process with the frontal process of the malar bone, and by the part just behind this with the orbital process of the malar.

Temporal Bone.

Squamous Portion.

The squamous portion articulates by the upper part of its semicircular border with the lower border of the parietal bone; by the front part of the same border with the posterior border of the outer surface of the greater wing of the sphenoid; by the lower part of the same border with the outer part of the posterior border of the upper surface of the greater

wing of the sphenoid; by the anterior part of the glenoid fossa with the condyle of the inferior maxilla; by the extremity of the zygomatic process with the zygomatic process of the malar bone.

Mastoid Portion.

By its upper border with the posterior inferior angle of the parietal; by its posterior border with the outer half of the lower border of the occipital bone.

Petrous Portion.

The petrous portion articulates by its posterior border with the inner half of the lower border of the occipital bone; by its anterior border with the middle part of the posterior border of the upper surface of the greater wing of the sphenoid.

Sphenoid Bone.

Body: By the posterior surface of the body with the basilar process of the occipital; by the ethmoidal spine with the sphenoidal notch of the cribriform plate of the ethmoid; by the crest with the upper part of the posterior border of the perpendicular lamella of the ethmoid; by the surface on each side of the crest with the posterior extremity of the lateral mass of the ethmoid, through the medium of the pyramid of Wistar, by which it also articulates with the posterior surface of the orbital and upper surface of the sphenoidal process of the palate bone; by the rostrum and vaginal processes with the upper border of the vomer.

Greater Wing: By the middle part of the posterior border of its upper surface with the anterior border of the petrous bone; by the outer part of the same border with the lower part of the semicircular border of the squamous portion of the temporal; by the posterior border of the outer face with the anterior part of the semicircular border of the squamous portion of the temporal; by the upper border of the outer face, with the anterior inferior angle of the parietal and with the frontal bone; by the anterior border of the outer face with the orbital process of the malar bone; by the upper border of the orbital face with the straight border of the frontal bone, *i. e.* sphenoidal triangle of the frontal; by the outer border of the orbital face with the orbital process of the malar; by the triangular rough surface between the outer and orbital faces, *i. e.* the frontal triangle, with the triangular surface at the junction of the semicircular and straight borders of the frontal bone, *i. e.* the sphenoidal triangle.

Lesser Wing: By its anterior border the lesser wing articulates with the posterior border of the orbital plate of the frontal.

Pterygoid Process: By its anterior border with the posterior border of the perpendicular plate of the palate bone; by the triangular interval between the lower part of its two plates with the tuberosity of the palate bone; by the inner side of its base with the posterior part of the outer surface and posterior border of the sphenoidal process of the palate bone.

Ethmoid Bone.

Horizontal Plate: By its lateral and anterior borders with the circumference of the ethmoidal fissure of the frontal; by the sphenoidal notch with the ethmoidal spine of the sphenoid.

Perpendicular Lamella: By the upper part of its posterior border with the crest of the sphenoid; by the lower part of its posterior border with the upper part of the anterior border of the vomer; by the upper part of its anterior border with the nasal spine of the frontal; by the lower part of its anterior border with the crest of the nasal bones.

Lateral Mass: By its upper surface it is continuous with the lower surface of the horizontal plate; by its posterior extremity with the anterior face of the body of the sphenoid bone, through the medium of the pyramid of Wistar; by its anterior extremity with the inner face of the lachrymal bone and with the inner face of the nasal process of the superior maxillary; by the upper border of the os planum with the horizontal plate, by the lower border of the os planum with the inner border of the orbital face of the superior maxillary bone, and behind that with the orbital process of the palate bone; by the posterior border of the os planum with the front of the body of the sphenoid; by the anterior border of the os planum with the posterior border of the lachrymal bone; by the part below the os planum with the inner face of the superior maxillary bone; by the unciform process with the ethmoidal process of the inferior turbinated bone; by the anterior extremity of the middle turbinated bone with the superior turbinated crest of the nasal process of the superior maxillary; by the posterior extremity of the middle turbinated bone with the superior turbinated crest of the vertical plate of the palate bone.

Nasal Bone.

By its upper border with the nasal notch of the frontal bone; by its outer border with the nasal process of the superior maxillary; by its inner border with its fellow; by the crest of the two bones, above, with the nasal spine of the frontal; below, with the lower part of the anterior border of the perpendicular lamella of the ethmoid.

Superior Maxillary.

The superior maxillary bone articulates by its body and processes.

Body: By the lower part of its posterior border with the front of the tuberosity of the palate bone; by the internal border of its orbital surface, from before backwards, with the lower border of the lachrymal bone, the os planum of the ethmoid and the anterior face of the orbital process of the palate bone: Antero-externally the orbital face articulates with the lower part of the internal, or posterior border of the orbital process of the malar; by its internal face the body articulates, by the part posterior to the aperture of the sinus with the anterior border, the maxillary process and most of the outer surface of the vertical plate of the palate; above the aperture with the outer surface of the lateral mass of the ethmoid, below the os planum; below the aperture with the maxillary process of the inferior turbinated bone; in front of the aperture with the projection on the anterior border of the lachrymal and the lachrymal process of the inferior turbinated; by the inferior turbinated crest with the anterior extremity of the inferior turbinated.

Malar Process: By the malar process with the maxillary process of the Malar.

Palate Process: By the inner border of the palate process with the inner border of the opposite palate process and with the anterior part of the lower border of the Vomer; by its posterior border with the anterior border of the horizontal plate of the palate.

Nasal Process: By its upper border with the nasal notch of the frontal; by the inner edge of its posterior border with the inner edge of the anterior border of the lachrymal; by the upper part of its internal surface with the anterior extremity of the lateral mass of the ethmoid; by the superior turbinated crest with the anterior extremity of the middle turbinated bone; by its anterior border with the posterior border of the nasal bone.

Palate Bone.

The palate bone articulates by its two plates.

The horizontal plate articulates by its inner border with the opposite bone and with the posterior part of the lower border of the Vomer; by its anterior border with the posterior border of the palate process of the superior maxillary.

The Perpendicular Plate articulates by most of its external surface, its anterior border and maxillary process with the inner face of the body of the superior maxillary, behind the aperture into the antrum; by its supe-

rior turbinated crest with the posterior extremity of the middle turbinated bone; by its inferior turbinated crest with the posterior extremity of the inferior turbinated bone; by its posterior border with the anterior border of the pterygoid process of the sphenoid; by the anterior face of the tuberosity with the lower part of the posterior border of the body of the superior maxillary and by its posterior face with the lower part of the anterior edge of the pterygoid process of the sphenoid; by the anterior face of its orbital process with the posterior part of the internal border of the orbital face of the body of the superior maxillary; by its internal face with the external surface of the lateral mass of the ethmoid, below and behind the os planum; by its posterior face with the front of the body of the sphenoid, through the pyramid of Wistar. By the upper surface of the sphenoidal process with the lower surface of the vaginal process of the sphenoid; by its posterior border and the posterior part of its outer face with the inner side of the base of the pterygoid process of the sphenoid.

Vomer.

The vomer articulates by its borders.

By the groove on its upper border with the rostrum of the sphenoid; by its alæ with the opposing faces of the vaginal process and lower surface of the body of the sphenoid; by its lower border, posteriorly, with the crested inner border of the horizontal plate of the palate and anteriorly with the crested inner border of the palate process of the superior maxillary; by the upper part of the anterior border with the lower part of the posterior border of the perpendicular plate of the ethmoid.

Inferior Turbinated Bone.

By its anterior extremity with the inferior turbinated crest of the superior maxillary; by its posterior extremity with the inferior turbinated crest of the palate; by the lachrymal process with the edges of the lachrymal sulcus of the inner face of the body of the superior maxillary and with the projection on the anterior border of the lachrymal; by the maxillary process with the lower margin of the aperture of the antrum; by the ethmoidal process with the unciform process of the ethmoid.

Lachrymal Bone.

The lachrymal bone articulates by its upper border with the internal angular process of the frontal; by its posterior border with the anterior border of the os planum; by its lower border with the front part of the internal border of the orbital plate of the superior maxillary; by the

inner edge of the anterior border with the inner edge of the posterior border of the nasal process of the superior maxillary and by the projection from the lower end of this border with the edges of the lachrymal sulcus on the inner face of the body of the superior maxillary and with the lachrymal process of the inferior turbinated bone and by the back part of the internal surface with the anterior extremity of the lateral mass of the ethmoid.

Malar Bone.

The malar bone articulates by its processes and by the anterior border of its body, which articulates with the anterior border of the malar process of the superior maxillary.

By the Frontal Process with the external angular process of the Frontal.

By the Maxillary Process with the malar process of the superior maxillary.

By the Zygomatic Process with the zygomatic process of the temporal bone.

By the Orbital Process; the lower part of its posterior border articulates with the orbital surface of the superior maxillary, antero-externally; the upper part of its posterior border, with the outer border of the orbital plate of the greater wing of the sphenoid.

Inferior Maxillary Bone.

The inferior maxillary bone articulates by its condyles with the squamous part of the glenoid fossa of the temporal bone.

The Hyoid Bone.

The hyoid bone, or lingual bone, is placed in the upper, front part of the neck at the base of the tongue. It is U shaped and lies horizontally, being a symmetrical bone. It is an isolated bone, but is connected by a ligamentous cord, on either side, with the styloid process of the temporal bone; occasionally this cord becomes ossified and then a complete bony arch is formed between the two temporal bones through the hyoid bone. It is divided for study into body and four cornua, or projections. The body presents two surfaces, two borders and two extremities. The anterior surface looks upward and slightly forward and presents four depressions, separated by a crucial ridge; the confluence of the arms of the ridge producing a prominence called the tubercle. The posterior face looks downwards and slightly backwards; is concave, both transversely and vertically, presenting a deep concavity. The upper border faces

backwards and is rounded and rough. The lower border faces forward, is protuberant and marked by muscular attachment. The extremity is oval and roughened by cartilaginous attachment. The greater cornu stands backwards from the extremity of the body, on either side, and is rounded, grows smaller, but is terminated posteriorly by a nodular enlargement. It is slightly flattened vertically.

The lesser cornu is, until old age, cartilaginous; it is a mere nodule of cartilage, hook like and about a quarter of inch long; its direction is upward, backward and slightly outward and it articulates by a diminutive joint at the junction of the body, and greater cornu. It becomes calcified and its joint obliterated only very late in life.

THE LIGAMENTS.

The study of joints, or articulations, is the study of the relation between bones, more particularly of the surfaces of apposition and the means by which the bones are held together and at the same time permitted to move upon one another. In the study of osteology it has been seen that the articular surfaces of the different bones present widely varying appearances; upon these differences depends the classification of joints. In some joints the opposing surfaces present interlocking, tooth-like processes, so that the union of the bones results in an immovable joint. This form of articulation is called synarthrosis.

The contiguous surfaces may be roughened, showing the attachment of ligamentous fibres passing directly between the bony faces; or the fibres may have been attached through the medium of cartilage, coating the bony surfaces. This indicates a joint in which motion is very slight, consisting of a twisting of the ligamentous fibres; and the articulation is known as amphiarthrosis.

The bony surfaces, lastly, may be smooth and polished, as a result of mutual friction—indicating a freely movable joint of the class, called diarthrosis.

The three classes of joints, then are—1st, Synarthrodial, or immovable joints; 2d, Amphiarthrodial, or partially movable; and 3d, Diarthrodial, or freely movable joints.

Besides the bones, there are other structures which contribute to the formation of a joint, as follows: In the Amphiarthrodial and Diarthrodial joints, the bones are held together by ligaments. In the Amphiarthrodial these not only pass from bone to bone, exterior to the joint, but directly between the bones, within the joint, forming what are called interosseous ligaments. In the Diarthrodial joints, as a rule, no ligamentous fibres are attached to the articulating surfaces of the bones; the ligaments, more or less completely surrounding the joint, are attached to both bones beyond the articular surfaces. The fibres may entirely surround the joint forming a capsular ligament, or they may be gathered into separate bundles.

In the Diarthrodial joints the opposing bony surfaces are coated by encrusting, or articular cartilage, which, on its deep face, is firmly attached to the bone, and presents a perfectly smooth, free surface towards the opposing bone.

In order to lessen friction, and render motion entirely easy, diarthrodial joints possess a secreting, serous-like membrane, called the synovial membrane, which secretes a viscid, glairy fluid, called synovia. The syno-

vial membrane, in very early life, is said to be a closed sac, coating the entire joint; but soon the portion covering the encrusting cartilage is worn away, or becomes inconspicuous.

If joints are subject to very frequent motion, the effect of friction is further guarded against by a plate of fibro-cartilage, called the inter-articular cartilage. This is a more or less flat, circular plate of cartilage interposed between the encrusting cartilages of the bony surfaces, and attached only by its circumference to the ligaments. When this exists entire, the joint will have two synovial membranes, but occasionally the plate is worn through and then the two membranes communicating, there is virtually but one.

Synarthroidal Joints.

The immovable joints are almost confined to the bones of the skull, the articulations between which are generally called sutures.

There are several varieties of suture: 1st. Dentate, or Serrate, in which edges of the bones present interlocking processes, called dentate when long and tooth-like, and serrate when short, like the teeth of a saw. 2d. Suture by Harmony, in which two roughened surfaces come in contact, as the inner border of the palate processes of the two superior maxillary bones. 3d. Schindylesis, where the edge of one bone is received in a groove in another, as the articulation between the vomer and the sphenoid. 4th. Gomphosis, where a bone is received into a corresponding cavity in another. This term is applied to the union between the teeth and their sockets, and is really no articulation.

Diarthrodial Joints.

The diarthrodial joints, in accordance with the varying shape of the articular surfaces, are divided into six varities.

1st. Arthrodial, formed by more or less flat, plane surfaces, so that motion is much restricted.

2d. Hinge or trochlear, or ginglymoid, characterized by the presence of a pulley on one of the articular surfaces. In this joint motion can occur as a rule, in only two directions.

3d. Condyloid, in which one element is a condyle, the other a proper receiving cavity. These joints are generally capable of very free movement.

4th. Saddle shaped, or concave-convex joints, or joints of reciprocal reception, where both surfaces are saddle-shaped and mutually interlock. The examples of this form of joint are sterno-clavicular, temporo-maxillary, trapezio-metacarpal and calcoaneo-cuboid.

5th. *Pivot, or trochoid joints.*—There are only two of these, alto-axoid and radio-ulnar. They present an osseo-ligamentous ring, in which a part of one bone is received; this, in the first example, acting as a pivot around which the other bone revolves; while, in the second case, it rotates on its own axis.

6th. Ball and socket, or enarthrodial joints.—These present a more or less spherical head, as one contribution, while a receiving cavity is the other. The two important examples of this variety are the shoulder and hip, in both of which motion is very free.

In describing a joint, the following heads have to be considered:

1st. The class and variety. 2d. The bony contributions. 3d. The ligaments. 4th. The synovial membrane. 5th. The inter-articular cartilage, perhaps. 6th. The motions of which the joint is capable. 7th. The muscles which strengthen the joint, if any.

As numerous as the motions seem to be, they can all be referred to the following:

(*a*) Gliding, which occurs to some extent in all diarthrodial joints, but is peculiarly characteristic of the arthrodial. It consists of the slipping of one, more or less, flat and plane surface on another.

(*b*) Flexion—angular movement of a segment of the body in an antero-posterior vertical plane, generally forward, but in some cases backward.

(*c*) Extension—the reverse of flexion.

(*d*) Abduction—the movement of a segment away from some established mid line, generally that of the body.

(*e*) Adduction—the reverse of abduction.

(*f*) Circumduction—the partial performance in rapid and regular succession of the four preceding movements, passing, in inward circumduction, from flexion to adduction, to extension, to abduction, and again to flexion. In outward circumduction the order is reversed. In the performance of this movement, the moving segment circumscribes a cone-shaped space, the apex of which is at the joint and the base at the distal extremity of the moving segment.

(*g*) Revolution, or false rotation. This occurs at but two joints, the atlo-axoid and radio ulnar. In the first case, the atlas revolves around the odontoid process as an axis; in the latter the radius rotates around its own axis in the ring formed by the orbicular ligament and the lesser sigmoid cavity.

(*h*) Rotation, or true rotation. This is almost limited to two joints, the shoulder and the hip, and, as it happens, can be defined in the same terms for both, viz: movement outward or inward around a line drawn

from the innermost point of the humerus or femur, to the innermost point of the inner condyle of either bone.

6th. A statement of the mechanism of motion—that is, of the changes which occur in the relative positions of the articulating surfaces during the performance of any given motion.

7th. The muscles which are in contact with the ligaments of the joint, and which may be considered as imparting strength to the articulation.

8th. In the important joints, the arteries and nerves distributed to them.

The Articulations of the Vertebral Column.

The articulations of the spinal column may be divided into those of the (1st) Column in general; (2d) Atlo axoid; (3d) Occipito-atloid; (4th) Sacro-vertebral.

Articulations of the Spine in General.

Each vertebra articulates with the vertebra above and the one below by a joint of the diarthrodial class, and arthrodial variety, on each side, formed by the inferior and superior articular processes. The ligaments are capsular around the articulating surfaces, and those which bind the same segments of the different vertebræ together, the common ligaments of the spine.

Articulation of the Articular Processes.

The articulation between contiguous articular processes is a diarthrodial joint of the arthrodial variety, presenting a synovial membrane and one ligament, an imperfect capsular ligament.

The Ligaments of the Spine in General—

Ligaments of the Bodies.

The bodies of the vertebræ are connected by means of intervertebral disks and anterior and posterior common ligaments. The intervertebral disk is found lying between the opposing surfaces of two adjacent vertebræ, firmly adherent to each. In shape it corresponds exactly with the bodies between which it lies; in thickness it varies with the different regions of the spine. Collectively, the disks form about one-fourth the length of the column and they are found between all the bodies except the first and second, being absent there because the atlas has no body. It is formed externally, of concentric laminæ of fibrous tissue and fibrocartilage, the centre of the disk being a soft, pulpy mass.

The anterior common ligament is found descending along the front of the bodies from the axis to the sacrum, widening as it descends. It consists of several superimposed layers of fibres, the deepest of which are short and attached only to adjacent bodies, while the superficial are long and extend over four, or five vertebræ.

The posterior common ligament is found within the spinal canal, attached to the back of the bodies and extending from axis to sacrum. Like the anterior, it consists of several layers of fibres, but, unlike that ligament, narrows as it descends; and, instead of having straight edges, is scalloped, widening over each intervertebral disk and narrowing over the bodies.

Ligaments of the Laminæ.

Two adjacent laminæ are held together by yellowish ligamentous fibres, called ligamenta subflava, attached to the anterior surface of the lamina above and the posterior surface of the one below; this is necessitated by the imbricated arrangement of the laminæ.

Ligaments of the Spinous Processes.

The spinous processes are connected by two ligaments—supra and inter-spinous. The supra-spinous is a rounded cord extending from the seventh cervical vertebra to the sacrum, and attached to the tips of the spinous processes; it is continued upward to the occipital bone by the ligamentum nuchæ, which takes its place in the neck.

The inter-spinous ligament is attached to the adjacent edges of the spinous processes, is unimportant and is found only in the dorsal and lumbar regions.

Ligaments of the Transverse Processes.

The transverse processes are held together in the lower dorsal and lumbar regions only, by thin scattered fibres called inter-transverse ligaments, each extending between adjacent processes.

The Atlo-Axoid Articulation.

The articulation between the Atlas and the axis consists of a diarthrodial and arthrodial joint on each side, formed by the articular processes, as seen between other vertebræ, and of a pivot joint, in front, between the posterior face of the anterior arch of the atlas and the front of the odontoid process of the axis. The ligaments of this articulation are six in number.

1st. Two anterior atlo-axoid, one of which is a cord extending from

the anterior tubercle of the atlas to the front of the base of the odontoid process; the other, lying beneath, is a membraneous layer, attached to the anterior arch of the atlas and the base of the odontoid process and to the body of the axis.

2d. The posterior-atlo-axoid is a membrane-like ligament attached above to the posterior arch of the atlas and below to the lamina of the axis.

3d. The transverse passes horizontally across the foramen in the atlas, behind the odontoid process, which it binds to the anterior arch of the atlas. As it passes over the odontoid process, it sends a bundle of fibres downward, to be attached to the base of the process, and another upward, to be attached to the basilar process of the occipital, assuming the shape of a Greek cross, from which it is called the cruciform ligament.

4th. Two capsular ligaments connect the articular processes.

Occipito-Atloid Articulation.

This is a movable joint of the condyloid variety, the articulating surfaces being the two condyles of the occipital bone, above, and the two superior articular processes of the atlas, below. The ligaments are:

1st. Those between the atlas and occipital bone, seven in number.

2d. Those between the occipital bone and axis, four in number.

1st. The anterior occipito-atloid consists of two parts, a superficial rounded cord on the middle line, extending from the basilar process to the anterior tubercle of the atlas; and a ligamentous membrane, attached above to the anterior margin of the foramen magnum and below to the anterior arch of the atlas.

2d. The posterior occipito-atloid is a broad membrane-like ligament passing between the posterior margin of the foramen magnum and the posterior arch of the atlas.

3d. The two capsular ligaments, one on each side, are each attached above to the condyle and below around the articulating surface of the superior articular process of the atlas.

4th. The two lateral occipito-atloid, one on each side, extend from the transverse process of the atlas to the transverse ridge, process, of the occipital bone.

Occipito-Axoid Ligaments.

The occipito-axoid appears to be a continuation of the posterior common ligament of the spine. It is attached to the posterior surface of the body of the axis, and passes up, covering over the odontoid process and cruciform ligament, to be attached to the basilar process.

The odontoid ligament consists of three parts, having a common attachment to the extremity of the odontoid process below, while above they separate, one being attached to the front margin of the foramen magnum and one to each lateral margin. The three parts are sometimes described as three ligaments under the name of check ligaments.

Sacro-Vertebral Articulation.

The joint between the sacrum and last lumbar vertebra, is similar to that between two vertebræ, the articulating surfaces being the articular processes of the two bones. The ligaments are the same as between any two vertebræ, with the addition of two ligaments on each side, the *ilio-lumbar* and *lumbo-sacral*, which are generally considered among the ligaments of the pelvis. The ilio-lumbar extends from the transverse process of the fifth lumbar vertebra outward to the ilium just above and in front of the ear-shaped articular surface. The lumbo-sacral passes from the transverse process of the fifth lumbar vertebra downward and outward to the wing of the sacrum.

Movements of the Spinal Column.

Motion at the intervertebral joints is very slight between any two vertebræ, but the aggregate is considerable. The movements are flexion, extension, right and left lateral movements—right or left abduction, or adduction—rotation and circumduction.

Flexion is the bending of the column forward. The mechanism of this motion is that the inferior articular processes glide upward and backward on the superior, the front of the intervertebral disks being compressed and the laminæ and spinous processes separating.

Extension is the reverse of flexion. It is restricted by the anterior common ligament and by the spinous processes. Its mechanism is the exact reverse of flexion.

Lateral motion, or abduction, is a bending of the column to one or the other side; it is limited by the transverse processes and by the intervertebral disks. During its performance, the inferior articular processes, on the side towards which motion occurs, glide downward while the opposite ones pass upward.

Rotation consists in the movement of the column around its own axis. It can occur, of course, to either side. The mechanism is as follows: the inferior articular processes, on the side towards which motion occurs, move backwards while those opposite move forward, the fibres of the intervertebral disks being twisted and stretched and the spinous processes moving away from the side towards which motion occurs.

Circumduction is the partial performance, in succession, of flexion, abduction, adduction, extension, so that the head and trunk circumscribe the base of a cone-shaped space, the apex of which is in the lumbar region where the centre of motion is. In the performance of the various movements, the cervical region is the freest and the dorsal the least free.

The atlo-axoid articulation possesses, in addition to these movements, the freedom of revolution, the atlas, conveying the skull with it, moving around the odontoid process as on an axis. In this movement the inferior articular process of the atlas, on the side towards which motion occurs, glides backward, and the opposite one forward, on the superior articular process of the axis, while the anterior arch of the atlas moves on the front of the odontoid process. This movement is restricted chiefly by the odontoid ligaments.

Motion of the occipito-atloid articulation is confined to flexion and extension. In flexion the skull goes forward and downward, and the condyle moves upward and backward in the receiving cavity. The mechanism of extension is the reverse.

Costo-Vertebral Articulation.

The parts of the skeleton which enter into a costo-vertebral articulation are the posterior extremity of the rib, the body, and transverse process of a dorsal vertebra and the intervertebral disk.

This articulation is of the diarthrodial class and the arthrodial variety. The ligaments which connect the head of the rib with the vertebral column are the anterior costo-vertebral, capsular and interarticular.

The anterior costo-vertebral is attached to the anterior aspect of the head of the rib, and radiates in three bundles, the upper of which is attached to the body of the vertebra above, the lower to the vertebra below, and the middle to the intervertebral disk. Owing to the divergence of its fibres, this ligament is known as the stellate. The arrangement differs from the foregoing description in the first, eleventh and twelfth ribs, where the ligament is attached to only one vertebra, as the articular facet is furnished wholly by one vertebra.

The capsular ligament consists of a few scattered fibres around the articulation.

The interarticular ligament is attached to the ridge on the head of the rib and to the intervertebral disk, thus dividing the joint into two parts, each furnished with a separate synovial sac. For the reason above given, the first eleventh and twelfth have no interarticular ligament and but one synovial sac.

The articulation between the ribs and the transverse processes, known

as the costo-transverse articulation, presents three ligaments—anterior, middle and posterior costo-transverse.

The anterior costo-transverse extends from the neck of the rib to the transverse process above; the middle, or interosseous, extends from the posterior surface of the neck of the rib directly backward to the transverse process; the posterior extends from the tubercle of the rib to the apex of the transverse process.

Temporo-Maxillary Articulation.

This articulation is formed by the condyle of the lower jaw and the glenoid cavity of the temporal bone.

This is a diarthrodial joint of the condyloid variety, and presents four ligaments, viz: internal and external lateral, capsular and stylo-maxillary and an inter-articular fibro-cartilage, which is sometimes perforated; when this is the case, there is but one synovial sac, otherwise there are two, one between the cartilage and the condyle and the other between the cartilage and the glenoid cavity.

The external lateral ligament is attached to the zygoma above, from its tubercle forward, and, passing downward and backward, is attached, below, to the outer border of the neck of the condyle.

The internal lateral is attached above to the extremity of the spinous process of the sphenoid bone, and, below, to the shelf of bone forming the lower margin of the inferior dental foramen on the inner face of the ramus of the lower jaw.

The capsular ligament consists of thin scattered fibres around the joint.

The stylo-maxillary is, properly, not a ligament of this joint. It extends from the styloid process of the temporal bone to the angle and posterior border of the ramus of the lower jaw.

The movements at the joint are four, viz: depression, elevation, a lateral and a forward movement. In depression the lower jaw is separated from the upper, the lower receding while the upper is almost stationary. The mechanism consists in a rolling forward of the condyle on the eminentia articularis and, when exaggerated, may lead to dislocation.

Elevation is the reverse of depression.

In the lateral movement, the lower jaw is twisted to one side, as in grinding between the molar teeth. The movement is checked by the condyle, of the side towards which motion occurs, coming in contact with the inner limit of the glenoid cavity.

Costc–Sternal Articulation.

The ribs have attached to their anterior extremities the costal cartilages, which prolong the seven true ribs to the side of the sternum, where the cartilages are received into the pits found there and are held in place by ligamentous fibres passing from them to the sternum in front and behind. The cartilages of the second and third ribs have also each an inter-articular ligament.

The Articulations of the Pelvis.

The articulations of the pelvis are four, viz: that between the fifth lumbar vertebra and the sacrum, that between the sacrum and coccyx, that between the sacrum and the os innominatum of each side and that between the two ossa innominata.

The ligaments of the sacro-vertebral articulation were described with those of the spine. The coccyx is held to the sacrum by a small intervertebral disk and by ligamentous fibres before and behind.

The ossa innominata are held to the sacrum by an articulation between the sacrum and the ilium on each side, and by two ligaments known as the greater and lesser sciatic. The sacro-iliac articulation, or symphysis, or synchondrosis, is effected by the auricular surface of the sacrum and ilium and two ligaments, anterior and posterior sacro-iliac.

The anterior sacro-iliac consists of a thin plane of fibres passing between the front of the sacrum and the ilium.

The posterior sacro-iliac is a large, strong mass of ligamentous fibres which pass from the rough surface behind the auricular surface of the ilium to the similar one of the sacrum, filling the deep depression which would otherwise exist there.

The two sacro-sciatic ligaments have common attachment to the edge of the coccyx and sacrum and the posterior inferior process of the ilium. As the mass passes forward and outward, one part, the lesser sciatic ligament, is attached to the spine of the ischium, while the rest, as the greater sciatic, continues its course to be attached to the tuberosity and ramus of the ischium.

The aperture above the lesser sciatic ligament is known as the great sacro-sciatic foramen, and the one between the two ligaments as the lesser sacro-sciatic foramen.

The articulation between the ossa innominata is found between the two pubic bones, and is known as the symphysis pubis. Each bone presents an oval articular surface, whose long diameter is downward and back-

ward, coated by a thin plate of encrusting cartilage. The two plates are in contact only at the back part, leaving, in front, a wedge-shaped space filled by fibres passing between the two plates. Besides this interarticular ligament, there are four others—superior, consisting of fibres passing between the two bones above; inferior, fibres passing between the two bones below, and filling in the interval between the two rami, so as to form a smoothly-curved arch; anterior, fibres passing between the bones in front, and posterior consisting of similar fibres behind.

Sterno-Clavicular Articulation.

This is a movable joint of the saddle-shaped variety, formed by the upper end of the sternum, the cartilage of the first rib, and the inner extremity of the clavicle.

The cartilage of the first rib has a depression on its upper border, which aids in furnishing a receiving cavity for the inner extremity of the clavicle.

The ligaments of this joint are three in number—capsular, costo-clavicular and inter-clavicular. The capsular ligament is attached to the margin of the articular surface of the sternum, clavicle and cartilage of the first rib. It is sometimes spoken of as two ligaments, the anterior and posterior sterno-clavicular, continuous above and below. The costo-clavicular is attached to the lower surface of the clavicle and passes downward and inward to seize the upper border of the cartilage of the first rib. The inter-clavicular seizes the inner extremity of the clavicle on its upper aspect, where it is continuous with the capsular ligament, and, passing across the top of the sternum, sinking into the semilunar notch, seizes the opposite clavicle in the same manner.

The joint is provided with an inter-articular fibro-cartilage which also acts as a ligament. Above, it is attached to the upper part of the articular surface of the clavicle; below, at the junction of the sternum with the cartilage of the first rib. It is often much worn, especially in laboring men, the degree of attrition being greater on the right side, owing to its more frequent use. The joint, of course, presents two synovial sacs.

The movements are slight, but in every direction, upward, downward, backward and forward. The inner end of the clavicle moves in an opposite direction to that in which the outer end moves, the cartilage of the first rib forming a fulcrum.

Scapulo-Clavicular Articulation.

This is a movable joint of the arthrodial variety. The articulating surfaces are an oval facet on the outer extremity of the clavicle and a

corresponding facet on the anterior edge of the acromion process of the scapula. It must be observed that the clavicle, in its outward course, passes just above the coracoid process of the scapula, and, while it does not articulate with it, receives a ligament from it.

The ligaments are two, capsular and coraco-clavicular. The capsular is attached around the articulating surfaces; the coraco-clavicular passes from the coracoid process to the under surface of the clavicle. When viewed from the front, this ligament presents a quadrilateral outline, and is called the trapezoid; from behind, it has a triangular shape, and is called conoid.

The joint is provided with an interarticular fibro-cartilage, which is often absent. The movements are slight but varied.

Ligaments of the Scapula.

Stretched between different points on the scapula are two ligaments, coraco-acromial and transverse. The coraco-acromial, thick and triangular, is attached by its apex to the tip of the acromion and by its base to the coracoid process, serving as a protecting arch for the shoulder joint. The transverse ligament passes over the supra-scapular notch, from one extremity to the other, converting it into a foramen.

The Shoulder Joint.

The shoulder joint, or scapulo-humeral articulation, belongs to the diarthrodial class and enarthrodial, or ball and socket, variety. The bony surfaces are the upper extremity of the humerus, and the glenoid cavity of the scapula.

The glenoid cavity is surrounded, and *slightly deepened*, by the glenoid ligament, which is a fibro-cartilaginous band, triangular on cross section, attached to the circumference of the cavity. Partially continuous with the upper part of the glenoid ligament is the tendon of the long head of the biceps muscle.

Holding the bones together is a capsular ligament, attached above to the scapula just behind the glenoid ligament, and, below, to the anatomical neck of the humerus, from which point it is prolonged over the tuberosities.

The upper part of the capsular ligament is thickened and is often individualized into a separate ligament, under the name of the coraco-humeral, extending from the base of the coracoid process to the greater tuberosity of the humerus. The ligament is remarkably long and loose, allowing separation of the humerus from the scapula to the extent of

nearly an inch, thus endowing the joint with great freedom of movement. The synovial membrane of this joint often communicates with a bursa beneath the tendon of the subscapularis muscle, and sometimes with one beneath the infra-spinatus.

The following muscles strengthen the various aspects of the joint:

Above, the supra-spinatus. Behind, the infra-spinatus. In front, the subscapularis. Forming a protecting cushion over the joint above, behind, to the outer side and in front, is the deltoid muscle, which covers the insertion of the other muscles and produces the bulge of the shoulder. In addition to these muscles, the joint is further protected from violence from above by the overhanging arch formed by the acromium and coracoid processes and the coraco-acromial ligament.

The movements are flexion, extension, abduction, adduction, circumduction and rotation. The mechanism is as follows:

In flexion, the humerus is carried forward and the head spins on its axis.

Extension is the reverse of flexion.

In abduction the humerus is carried outward, the head passing downward in the glenoid cavity and pressing against the inferior fibres of the capsular ligament, which may be ruptured by an exaggeration of this movement, producing downward dislocation.

Adduction is the reverse of this movement.

Circumduction is a combination of these movements, the head rolling around in the glenoid cavity.

In rotation the humerus revolves around an axis drawn from the centre of the head to the internal condyle—the head moving backward in inward and forward in outward rotation.

Radio-Ulnar Articulation.

The articulation between the two bones of the forearm forms a diarthrodial joint of the trochoid or pivot variety. The bones articulate at both the upper and lower extremity, being separated by the interosseous space throughout the shafts.

The ligaments holding the bones together are found at their upper and lower extremities and between their shafts. Above, the two bones are held together by one ligament, the orbicular which forms three-fourths of a ring, the other fourth being the lesser sigmoid cavity of the ulna. The ligament surrounds the articular rim of the radius and is attached by its two ends to the extremities of the lesser sigmoid cavity. The lower fibres are tightly stretched around the radius just below the head, rendering it very difficult to release that bone from its grasp.

The shafts are connected by two ligaments, the interosseous and the oblique. The oblique is a narrow band which passes downward and outward from the ulna, at the base of the coronoid process, to the radius just below the tuberosity. *It is often wanting.*

The interosseous membrane extends from the lower extremities of the bones upward about two-thirds the length of the shafts, leaving an interval above which is the oblique ligament. Its fibres are directed downward and inward between the inner border of the radius and the outer border of the ulna. About the lower third of the forearm, the membrane is pierced by a foramen for the anterior interosseous artery.

At their lower extremities the bones are held together by two ligaments and the triangular fibro-cartilage. The two ligaments are an anterior and a posterior passing across the two bones. The triangular cartilage tips the summit of the capitulum ulnæ and excludes it from the wrist joint. By its apex it is attached to the pit between the styloid process of the ulna and the capitulum ulnæ; by its base to the narrow rough surface separating the carpal and sigmoid cavities of the radius.

The movements are two, and in both the radius alone moves. It can move forward, pronation, or backward, supination, and in both the hand is carried with it. In these movements of rotation, or revolution, the radius rotates around an axis represented by an imaginary line drawn from the centre of the head of the radius through the centre of the capitulum ulnæ; consequently in performing pronation the sigmoid cavity of the radius moves forward on the articular rim of the capitulum ulnæ, the reverse occurring in supination, while the head of the radius rotates in the lesser sigmoid cavity and orbicular ligament.

The Elbow Joint.

The joint is of the movable class and hinge variety; its bony surfaces being furnished by the lower extremity of the humerus on the one hand and the upper extremities of the radius and ulna on the other.

As this is a ginglymoid joint it has no capsular ligament, but the bones are held in opposition by ligaments placed in front, behind and at the sides. As stated in describing the radio-ulnar articulation, the radius is held in the lesser sigmoid cavity by the orbicular ligament; and as revolution of the radius, which is demanded for free movement of the hand, would be impossible if the bone were seized by any ligaments which are attached to the humerus, for ligamentous fibres are inelastic, it will be found that certain ligaments of this joint, to avoid this interference, are attached to the orbicular ligament and that none of them seize the radius.

The ligaments of the joint are anterior, posterior, internal and external lateral.

The anterior ligament is attached above to the humerus just above the coronoid fossa; below, to the coronoid process and orbicular ligament.

The posterior ligament is thin and weak. Above, it is attached to the humerus just above the olecranoid fossa, below, to the groove on the olecranon process of the ulna.

The external lateral descends from the external condyle of the humerus to seize the orbicular ligament.

The internal lateral is triangular in shape. It is attached by its apex to the internal condyle of the humerus; below, it divides into two fasciculi, one of which is attached to the inner edge of that part of the greater sigmoid cavity found on the olecranon, and the other to that on the coronoid process.

The following muscles strengthen the articulation:

In front, the brachialis anticus.

Behind, the anconeus and triceps.

Externally, the muscles arising from the external condyle, notedly the supinator brevis.

Internally, the muscles arising from the internal condyle.

The movements are the two characteristic of a hinge joint—flexion and extension.

The mechanism of flexion is that the greater sigmoid cavity and the articular cup of the radius move forward on the trochlea and eminentia capitata of the humerus respectively. This movement is checked when the apex of the coronoid process impinges on the bottom of the coronoid fossa. Extension is the reverse of flexion, and is checked by the beak of the olecranon coming in contact with the bottom of the olecranoid fossa.

The Wrist Joint.

The wrist joint belongs to the movable class and condyloid variety. The condyle is furnished by the upper row of carpal bones, scaphoid, semilunar and cuneiform. Its long diameter is transverse. The receiving cavity is formed by the lower end of the radius and a plate of fibrocartilage lying on the lower extremity of the ulna. This cartilage cuts the ulna off from the joint. Its attachment was described with the radio-ulnar articulation.

The ligaments are four, anterior, posterior and two lateral.

The anterior is attached, above, to the front of the radius and ulna; below, to the front of the bones of the condyle.

The posterior is attached, above, to the back of the radius; below, to the back of the bones of the condyle.

The internal lateral is attached, above, to the styloid process of the ulna; below, to the cuneiform and pisiform bones.

The external lateral is attached, above, to the styloid process of the radius; below, to the scaphoid and trapezium.

The joint is strengthened by no muscles. Many tendons pass over it, but they are too slender, lax and free to give support.

The movements are flexion, extension, abduction, adduction and circumduction.

The mechanism in flexion is as follows: The condyle moves backward in its cavity, pressing against the posterior ligament, which may be ruptured by an exaggeration of this movement, producing backward dislocation of the carpus. This may be produced by a fall on the back of the hand when flexed.

Extension is the reverse of flexion.

In abduction the hand is moved away from the middle line, the condyle moving inward. Adduction is the reverse.

Circumduction is the combination of these movements.

Articulation of Carpus and Metacarpus.

The bones of the carpus, which lie in the same row, are held together by ligamentous fibres passing across them in front and behind, palmar and dorsal ligaments, and by fibres which seize the adjoining surface of opposing bones, called interosseous ligaments. Between the trapezium and trapezoid there is no interosseous ligament. In the same manner the metacarpal bones of the four fingers are held together at their bases. The two rows of carpal bones are held together by ligamentous fibres passing from one to the other in front and behind, palmar and dorsal ligaments and by two lateral ligaments, the external passing from the scaphoid to the trapezium, the internal from the cuneiform to the unciform.

The metacarpal bones of the four fingers are held to the second row of carpal bones by fibres in front and behind, palmar and dorsal ligaments, and, in one situation, by interosseous fibres extending from the adjacent parts of the os magnum and unciform to the bases of the third and fourth metacarpal bones.

The Trapezio-Metacarpal Joint.

This articulation belongs to the movable class and saddle-shaped variety. It is invested by a capsular ligament, and allows the four angular movements and their combination, circumduction.

The Metacarpo-Phalangeal Articulation.

The knuckle joint, or metacarpo-phalangeal, is of the movable class and condyloid variety. The condyle is furnished by the head of the metacarpal bone and the receiving cavity by the top of the corresponding phalanx, aided by a plate of cartilage known as the anterior ligament of the joint.

The ligaments are two lateral, seizing both bones on their lateral aspect just beyond the articular surface. The place of a posterior ligament is supplied by the extensor tendons of the finger. The anterior is not a ligament in the true sense of the word, being only a mass of fibro-cartilaginous material attached to the front edge of the articulating surface on the base of the phalanx, and increasing the receiving cavity. The movements are the four angular movements and their combination, circumduction.

Inter-Phalangeal Articulation.

The articulation between two phalanges is of the movable class and hinge variety, the head of one phalanx presenting the trochlear and the base of the other the corresponding surface. The ligaments are exactly similar to those of the metacarpo-phalangeal articulation but the movements are only two, flexion and extension.

The Hip Joint.

This joint is of the movable class and ball and socket variety, its bony elements being the acetabular cavity of the os innominatum and the upper extremity of the femur.

Surmounting the cavity, in the fresh subject, is a fibro-cartilaginous ring called the cotyloid ligament, continued over the notch in the margin. The part stretched over the notch is known as the transverse ligament. Occupying the depression in the bottom of the cavity is a cushion of fat.

The ligaments are the capsular and the ligamentum teres.

The capsular ligament encloses the joint closely; and, unlike, that at the shoulder is short and keeps the bones in close apposition. It is attached above to the brim of the acetabulum and below to the neck of the femur, extending in front the whole length of the neck, while behind it falls short of the posterior intertrochanteric line by one-half inch. The upper part of this ligament is much thicker than the rest, some five times. It receives there the support of what is called the ilio-femoral, or

Y ligament, which is attached above to the anterior inferior spinous process of the ilium and below to the spiral line and front of the great trochanter of the femur.

The ligamentum teres is a cord of fibres which, starting from the rough depression on the head of the femur, forks and is attached to the sides of the notch in the margin of the acetabulum.

Efficient to the amount of about twenty-six pounds in retaining the head of the femur in the acetabulum is atmospheric pressure, the head fitting closely from the exact moulding in the socket.

The muscles which strengthen the joint are as follows:

Above, the rectus and gluteus minimus. In front, the psoas magnus and iliacus internus. Internally, the pectineus and obturator internus. Behind, the outward rotators of the thigh, obturators, internus and externus, pyriformis, the gemelli and the quadratus femoris. Or, beginning at random and naming them in the order in which they lie around the joint, we have, gluteus minimus, rectus, iliacus internus, psoas magnus, pectineus, obturator externus, quadratus femoris, gemellus inferior, obturator internus, gemellus superior and pyriformis.

The movements are six in number and are the same as at the shoulder joint. The mechanism is also the same. As there dislocation occurs by exaggerated abduction, or adduction.

The Knee Joint.

The knee, the largest and most important joint in the body, belongs to the movable class and hinge variety. The bony elements are the lower extremity of the femur, above, the upper extremity of the tibia, below, and the posterior surface of the patella, in front.

Lying on each of the glenoid cavities is an imperfect plate of fibrocartilage, called semilunar, external and internal. Each plate is thickest at its circumference and slopes off to a thin edge towards the centre of the cavity, on which it lies. The internal is oval, its long diameter antero-posterior and its extremities terminate at the beginning of the depressions in front and behind the spine. The external is nearly circular and its extremities terminate at the base of the spine in front and behind, as it were between those of the internal. The circumference of each plate is held down on the margin of the glenoid cavity by short vertical fibres forming the coronary ligaments right and left. Passing across from the most prominent point of one plate to the other, anteriorly, is a small cord, called the transverse ligament.

The ligaments of the joint are anterior, posterior, two crucial and three lateral, one internal and two external.

The anterior ligament is known as the ligamentum patellæ, and extends from the lower end of the patella to the anterior tubercle of the tibia, the patella being held to the femur by the attachment of the triceps extensor cruris. It is the tendon of insertion of the triceps.

The posterior ligament covers the whole of the back of the joint, being attached, above, to the back of the femur, above the condyles, and below to the back of the tibia. Its middle portion is furnished by the tendon of the semi-membranosus.

The internal lateral ligament is a flattened band of fibres attached to the inner tuberosity of the femur, above, and the inner tuberosity of the tibia, below.

The long external lateral ligament extends as a round cord from the external tuberosity of the femur to the head of the fibula. The short external lateral lies behind the long and has the same attachment below, but above is attached to the groove below the outer tuberosity of the femur. It is really the tendon of origin of the popliteus.

The two crucial ligaments are found within the joint and are distinguished as anterior, or external, and posterior, or internal. The anterior is attached to the tibia in front of its spine and passes upward, outward and backward, to seize the inner face of the external condyle. The posterior is attached to the tibia just behind the spine and passes upward, forward and inward to seize the outer face of the internal condyle. The two crucial ligaments decussate in the joint—hence the name—and are connected where they cross.

Besides the foregoing, there are other, so-called, ligaments, but they are not true ligaments and have little or no influence in holding the bones together. Stretching from the notch between the condyles of the femur to a mass of fat which lies behind the ligamentum patellæ, there is a fold of synovial membrane which is called the ligamentum mucosum. The loose edges of this fold are known as the alar ligament.

The synovial membrane of the knee is the most extensive in the body. It is not only sufficient for the joint itself but it extends on the front of the femur from one to two inches above the articular surface. It is worthy of note that the synovial sac is not in contact with the posterior face of the ligamentum patella but is separated from it by a mass of fatty tissue.

Investing all these structures is the continuation of the fascia lata over the joint to become the deep fascia of the leg.

The muscles strengthening the joint are as follows:

In front triceps extensor cruris.

Behind gastrocnemius, popliteus and semimembraneous.

Externally, the tendon of the biceps flexor cruris.

The movements are flexion and extension. In flexion the leg is raised backward on the thigh, the glenoid cavities of the tibia moving backward on the condyles. The movement is checked when the leg is in contact with the back of the thigh.

Extension is the reverse of flexion.

It should be observed that in a state of semi-flexion the knee joint is capable of slight lateral movement, or rotation, as in eversion or inversion of the foot.

The Ankle Joint.

This joint belongs to the movable class and hinge variety. Its articular surfaces are contributed by the lower extremities of the tibia and fibula, above, and the upper surface of the astragalus below.

The ligaments are an anterior and two lateral. The anterior, thin and fatty, extends from the front of the tibia to the astragalus in front of the pulley.

The internal lateral, or deltoid, triangular in shape, is attached, above, by its apex to the inner malleolus, while, below, its base seizes the scaphoid, astragalus and os calcis. When cut through this ligament is seen to consist of two layers and to be very strong.

The external lateral is really three ligaments, although always described as one, consisting of three fasciculi, anterior, middle and posterior. The anterior fasciculus extends from the outer malleolus to the astragalus in front; the middle passes from the outer malleolus downward to the os calcis; and the posterior is attached to the inner aspect of the outer malleolus, posteriorly, and to the astragalus.

The place of a posterior ligament is supplied by the tendo Achillis. The movements are flexion and extension. In flexion the foot is carried forward on the leg, the astragalus moving backward on its receiving surface. Extension is the reverse. In eversion and inversion there is slight lateral movement when the foot is extended.

The Tibio-Fibular Articulation.

Extended between the tibia and fibula from just below the knee to the ankle joint is a strong ligamentous structure, called the interosseous membrane, the direction of whose fibres is downward and outward. In the upper part of this membrane is the aperture for the transmission of the anterior tibial artery. Besides this membrane the tibia and fibula are held together at both the upper and lower extremity.

The upper extremity, or head of the fibula, presents a more or less

circular articular facet, which plays on a corresponding facet situated on the outer tuberosity of the tibia. The bones are held together here by an anterior and a posterior ligament which pass from bone to bone in front and behind. The synovial membrane of this joint sometimes communicates with that of the knee.

The outer aspect of the lower extremity of the tibia presents a rough surface, which corresponds to one on the inner face of the lower extremity of the fibula, situated just above the articular inner face of the malleolar process. There is also a very narrow articular surface just below the rough surface on the tibia, perhaps.

The ligaments, like those at the upper extremity, are an anterior and a posterior, with the addition of a large mass of interosseous fibres passing between the adjacent rough surfaces.

The Articulations of the Tarsus.

The articulations of the tarsus consist of the articulation between the bones of each row and the union of the two rows.

Calcaneo-Astragaloid Articulation.

The two bones of the first row of the tarsus are held together by three ligaments, external, posterior and interosseous.

The external calcaneo-astragaloid extends from the outer side of the os calcis to the outer side of the astragalus.

The posterior calcaneo-astragaloid passes from the posterior extremity of the astragalus to the contiguous upper aspect of the os calcis and is but a continuation of the protective fibres, called the posterior ligament of the ankle.

The interosseous is by far the most important bond of union between the two bones. It consists of a large number of fibres, filling the sinus tarsi, and passing directly and obliquely between the surfaces contributed to form that canal.

The Articulation Between the Bones of the Second Row.

The bones of the second row are held together by fibres passing across the dorsal and plantar faces and by interosseous fibres between opposing surfaces.

The Articulation Between the two Rows.

The two rows of the tarsus are held together by three sets of ligaments, two sets passing from the os calcis to the cuboid and scaphoid, though

the latter does not articulate with it, and one set passing between the astragalus and scaphoid.

Calcaneo-Cuboid Articulation.

The ligaments binding the os calcis to the cuboid are four, two dorsal and two plantar.

The superior calcaneo-cuboid is thin and narrow and passes between contiguous surfaces of the bones on the dorsum of the foot.

The internal calcaneo-cuboid, or interosseous, is a thick short band of fibres springing from the depression between the os calcis and the astragalus and inserted into the inner side of the cuboid. At its origin it is closely blended with the superior calcaneo-scaphoid.

The long inferior calcaneo-cuboid is attached behind to the lower surface of the os calcis and in front to the lower surface of the cuboid and bases of the adjacent metatarsal bones, second, third and fourth, covering in, as it passes forward, the groove in which lies the tendon of the peroneus longus.

The short inferior calcaneo-cuboid lies deeper than the long and extends between the lower front part of the os calcis and the cuboid.

Calcaneo-Scaphoid Ligaments.

Connecting the os calcis and scaphoid are two ligaments, superior and inferior calcaneo-scaphoid.

The superior, one arm of the Y ligament, the other arm being furnished by the internal calcaneo-cuboid, passes forward and inward from the front upper part of the os calcis to the scaphoid.

The inferior calcaneo-scaphoid is much stronger than the superior and passes from the inner front aspect of the os calcis, beneath the head of the astragalus, to the lower surface of the scaphoid.

The Astragalo-Scaphoid Articulation.

The only ligament connecting the astragalus and the scaphoid is the superior astragalo-scaphoid, which is thin and weak and passes from the neck of the astragalus to the upper surface of the scaphoid.

The Tarso-Metatarsal Articulation.

The first metatarsal bone articulates with the internal cuneiform; the second, with the middle cuneiform, by its base, and laterally with the in-

ternal and external cuneiform bones, being jammed between these and extending farther back than the other metatarsal bones; the third articulates with the external cuneiform, and the fourth and fifth with the cuboid.

The tarsus is held to the metatarsus by dorsal and plantar ligamentous fibres and by three interosseous ligaments—one from the internal cuneiform to the second metatarsal and one from the external cuneiform to the third metatarsal.

The metatarso-phalangeal, the inter-phalangeal and the "intermetatarsal" are exactly similar to those of the hand.

THE VISCERA.

The Alimentary Canal and Appendages.

The alimentary canal begins at the mouth and ends at the anus, the intermediate portions being found in the neck, thorax and abdomen. In the neck are the fauces, pharynx and part of the œsophagus; in the thorax is the remaining portion of the œsophagus, while the rest of the canal is found in the abdomen.

The Mouth.

The mouth begins at the lips and terminates behind in a short constricted portion called the fauces. It is bounded above by the hard palate, below by the tongue and on each side by the cheeks.

The lips are two, upper and lower, separated by the transverse labial fissure. Each is formed chiefly by its segment of the orbicularis oris muscle, covered externally by skin and internally by mucous membrane, a concentric fold of which, called froenum labii, extends in the middle line from each lip to the gum behind. The cheek consists chiefly of the buccinator muscle, covered externally by skin and internally by mucous membrane, which is reflected from it to the gum and presents, opposite to the second molar tooth of the upper jaw, the opening, on a papilla, of Stenson's duct from the parotid gland. The hard palate is formed anteriorly by the meeting in the middle line of the palate processes of the superior maxillary, and posteriorly by the horizontal plate from each palate bone. It is bounded in front and at either side by the aveolar processes of the superior maxillary bones, containing the teeth of the upper jaw. It is covered by mucous membrane both above and below, forming the floor of the nasal fossæ above and the roof of the mouth below; on the latter aspect the mucous membrane is roughened by glands, called palatal and is continued on to the gums.

The floor of the mouth is formed by the anterior two-thirds of the tongue, the posterior third of the tongue forming the floor of the fauces, and, below that, entering into the formation of the anterior wall of the pharynx. The tongue is flattened from above downward, is conical in shape and curved in direction, being convex above antero-posteriorly, and extends from the hyoid bone behind to the incisor teeth in front, its base being adherent to the hyoid bone and its apex free and anterior. It is formed chiefly of muscular fibres, some of which are con-

fined wholly to the organ, and are called intrinsic muscles, while others are attached by only one end to the tongue, and are called extrinsic muscles. The tongue is covered on the superior surface, or dorsum, and on its sides by mucous membrane. Running through it from before backwards is a vertical fibrous septum, thicker behind than in front, dividing it into symmetrical halves. The intrinsic muscular fibres are transverse and longitudinal—the transverse and longitudinal lingualis.

The lingualis longitudinalis consists of fibres which extend from the hyoid bone, to which they are attached, to the tip of the tongue, and are found in a superficial layer on both the upper and lower surfaces of the organ, these two layers being separated by the lingualis transversalis, which consists of fibres attached to the fibrous septum and running out to the edge of the tongue. The so-called vertical lingualis is simply the continuation of the fibres of certain extrinsic muscles of the tongue, and, indeed, the longitudinal lingualis consists largely of such fibres.

The extrinsic muscles of the tongue are the stylo-glossus, hyoglossus, and two others, one of which, the genio-hyoglossus, belongs with the elevators of the hyoid bone, where it is described; the other, the palato-glossus, is considered with the soft palate.

Stylo-Glossus.

The stylo-glossus arises from the tip of the styloid process of the temporal bone, and, running downward and forward as a narrow band, is lost on the side of the tongue.

Action: It draws the tongue backwards into the mouth.

Hyoglossus.

The hyoglossus is a flat, quadrilateral muscle, which arises from the body and both cornua of the hyoid bone, and, passing directly upward, is inserted into the side of the tongue, to the inner side of the stylo-glossus.

Action: It carries the tongue downward and backward, increasing the size of the fauces.

The mucous membrane covering the dorsum of the tongue passes around the sides and tip, thus enveloping most of the organ, and leaves the lower surface to become continuous with that lining the gum of the lower jaw. In contact with the posterior part of the dorsum is the front of the epiglottis, which is held to it by three folds of mucous membrane, the glosso-epiglottic ligaments, middle and two lateral.

The Fauces.

The fauces, or isthmus of the fauces, is that narrow part of the alimentary canal which connects the mouth posteriorly with the front of the pharynx. It is about one and one-half inches long, about the same in width, and rather less in depth; the size, however, varying greatly, for its walls are chiefly formed of muscular tissue, which is peculiarly subject to reflex action.

The roof of the fauces is the soft palate; the floor is a part of the dorsum of the tongue; the sides are formed by two arching muscles, and, between them, the tonsil glands. The muscle in front is the palato-glossus, forming the anterior pillar of the fauces; that behind is the palato-pharyngeus, forming the posterior pillar of the fauces. The wall, in every aspect, is covered by mucous membrane.

Soft Palate.

The soft palate, or velum pendulum palati, is thin and flattened from above downward and forward. It is attached above to the posterior border of the hard palate and hangs downward and backward, separating the fauces from the upper part of the pharynx. It is prolonged, in the middle line below, by a nipple-like projection, some half an inch long, called the uvula. It is made up chiefly of muscular tissue and tendon, covered on both faces by mucous membrane, which above, is continuous with that lining the nasal fossæ and, below, with that of the fauces and mouth. The proper muscles of the soft palate are three, the levator palati, the tensor palati and the azygos uvulæ, but in addition there are two others which have their origin in the soft palate—the palato-glossus and palato-pharyngeus.

Levator Palati.

The levator palati arises from the rough surface on the basilar surface of the petrous bone, near its apex, and from the cartilaginous portion of the Eustachian tube, and descends to be lost in the soft palate. Its name indicates its action.

Tensor Palati.

The tensor palati is a small muscle which forms a right-angle on itself, hence its synomym of circumflexus. It arises from the scaphoid fossa of the pterygoid process, from the spinous process of the sphenoid bone and from the cartilaginous portion of the Eustachian tube, and, first descending vertically, then turning transversely inward around the ham-

ular process, it spreads out into a broad aponeurosis in the soft palate. Its action is indicated by its name.

Azygos Uvulæ.

From the posterior termination of the soft-palate there hangs pendulous, in the centre, a short, conical mass called the uvula, which, when dissected, is found to consist, exteriorly, of mucous membrane and, interiorly, of a pair of minute muscles, each of which, arising from the palate spine, descends beside its fellow and is lost in the mucous membrane of the uvula. These two muscles were formerly considered as one, hence their name. It is their presence in the uvula which accounts for its constant and varied movement.

Palato-Glossus.

The palato-glossus arises in the soft palate and passes downward and forward to terminate in the side of the tongue.

Action: It constricts the fauces, hence its synonym of constrictor isthmii faucium. It can also depress the soft palate.

Palato-Pharyngeus.

The palato-pharyngeus arises in the soft palate and passes downward and backward to enter the wall of the pharynx, where some of its fibres are lost, the rest being inserted into the posterior border of the thyroid cartilage. Its action is the same as the preceding muscle and its synonym, constrictor isthmii faucium posterior.

Pharynx.

Food, in order to reach the stomach, passes through four successive portions of the alimentary canal. The first two of these have been described, viz: the mouth and fauces. Leaving the latter, food enters the pharynx, whence it passes to the œsophagus, in which the pharynx terminates, and the œsophagus conveys it to the stomach.

But the pharynx not only serves as a channel for the food in its passage to the stomach; it also conducts air from the nostrils to the larynx; and since the nostrils are above the mouth and fauces, the pharynx must also extend upward beyond them, as it does, reaching the base of the skull. The opening of the pharynx into the larynx, through which air is transmitted, is found on the front of the pharynx just below the fauces. The air found in the tympanic cavity also passes through the pharynx,

by means of the Eustachian tubes, which open into the upper front part of the pharynx just behind the posterior nares. Seven openings are found in the pharynx, of which six open in front, viz · the two posterior nares, the two Eustachian tubes, the opening of the fauces, and that of the larynx. The seventh is the termination, inferiorly, of the pharynx in the œsophagus. The pharynx extends from the base of the skull to the œsophagus, which begins on the front of the body of the fifth cervical vertebra, *i. e.*, at the same level as the termination of the larynx, which lies on the front of the pharynx, and the commencement of the trachea. The pharynx is about four and a half inches long, tapering as it descends along the front of the upper five cervical vertebræ.

Structures.

The pharynx is lined by mucous membrane, resting on a thin fibrous coat. External to the mucous coat is a muscular coat, consisting, like that of the intestines, of circular and longitudinal fibres, but differing in that the muscular fibres are here red and not pale, and are gathered into bundles which are described as separate muscles. The circular fibres are arranged in flattened bundles on each side, each bundle intersecting its fellow of the opposite side on the middle of the back of the pharynx where they form a raphè. Each pair of bundles overlaps the lower edge of the pair above. When traced from the raphè forward it is seen that these fibres do not encircle the entire pharynx but pass from its sides to seek firm neighboring points of attachment, from which to exert traction, thus leaving the front of the pharynx devoid of muscular fibres, this part of its wall being formed by mucous membrane alone. The larynx resting on the front of the pharynx, is in contact with the mucous membrane and is embraced by these circular fibres. These muscles, from their action, are known as the constrictors of the pharynx; and as there are three separate bundles, they are described as superior, middle and inferior constrictors. The direction of their fibres is not horizontally backward but backward and upward.

Inferior Constrictor.

The inferior constrictor arises from the oblique line on the ala of the thyroid cartilage and surface behind it, from the side of the cricoid cartilage and from the two upper rings of the trachea It runs backward, its upper fibres passing obliquely upward, overlapping the middle constrictor and is inserted into the raphè of the pharynx.

Middle Constrictor.

The middle constrictor arises from both cornua of the hyoid bone, and from the stylo-hyoid ligament, a fibrous cord extending from the hyoid bone to the styloid process. The fibres radiate somewhat, spreading out on the side of the pharynx, and are inserted into the raphè. The inferior fibres are overlapped by the inferior constrictor, and the superior fibres overlap the superior constrictor. So great is this overlapping that when viewed from behind but little of the superior constrictor can be seen, the raphè of the middle constrictor extending to the basilar process.

Superior Constrictor.

The superior constrictor lies just beneath the skull and is overlapped by the middle. It arises from the lower one-third of the internal pterygoid plate, from its hamular process, from the pterygo-maxillary ligament, from the extremity of the molar ridge of the lower jaw, and by a few fibres from the side of the tongue. It passes backward, is inserted into the raphè, which is attached to the basilar process. The upper edge of this muscle presents a concave border, thus leaving an arched interval between it and the skull above, over which the fibrous tissue beneath the mucous membrane of the pharynx extends and is here so much thickened as to form a strong fibrous membrane.

The longitudinal fibres of the pharynx are, like the circular, gathered into bundles, of which there are two pairs. These are described as distinct muscles arising from points above the pharynx and inserted into it. One of them, the palato-pharyngeus, has been described as a part of the soft-palate; the other is known as the stylo-pharyngeus.

Stylo-Pharyngeus.

The stylo-pharyngeus arises from the inner side of the base of the styloid process and descends to the side of the pharynx, entering its wall between the superior and middle constrictors. Some of the fibres are lost in the pharynx, while some are continued to the posterior border of the thyroid cartilage. Action—it elevates and widens the pharynx.

Œsophagus.

The œsophagus continues the course of the alimentary canal from the termination of the pharynx, at the commencement of the trachea on the front of the body of the fifth cervical vertebra, down the front of the vertebral column, through the neck and thorax, to pierce the diaphragm at

the œsophageal opening, opposite the tenth dorsal vertebra and terminate at the cardiac orifice of the stomach. It is about nine inches long.

Relations—It first descends in the front of the two lower cervical and upper six dorsal vertebræ, and then continues its course, steadily diverging from the middle line to the left. It first lies on the middle line, but in the lower part of the neck and upper part of the thorax curves to the left slightly; about the third dorsal vertebra it returns to the mid line which it follows to the sixth dorsal, where it finally inclines to the left and forward.

For the study of its relations it may be conveniently divided into three portions. The first extends from its commencement to the first dorsal vertebra and lies in the neck; the second extends from the first to the sixth dorsal and lies in the upper part of the thorax in the back of the superior mediastinum; the third extends from the sixth dorsal to its termination and lies in the posterior mediastinum.

The relations of the first portion are as follows: In front is the trachea, to the left of which it has slightly curved at its termination. In the furrow between it and the trachea on each side is the recurrent laryngeal nerve; behind, it is separated from the vertebral column by the longus colli muscle; on each side is the common carotid artery, the left being the closer, owing to the curve of the œsophagus to that side. It is also in relation, laterally, with the lower part of the lateral lobes of the thyroid gland.

The second portion has the following relations: In front, as far down as the fourth dorsal vertebra, is the trachea, which separates it from the transverse part of the arch of the aorta. Below this it has in front first the left bronchus and then the pericardium. Behind, it has the longus colli muscle, separating it from the vertebral column. At its commencement it has to its right the terminal part of the innominate artery and, to the left of the terminal portion, the first part of the left common carotid and left subclavion artery. These are lateral relations of the first part also. To the left and slightly in front, above, is the thoracic duct, and in the groove between it and the trachea is the left recurrent laryngeal nerve; also to the left, below, is the descending part of the arch of the aorta and the commencement of the thoracic aorta. To the right of the lower part is the terminal part of the right vena azygos; lastly, laterally it is covered by the pleura.

The third portion has the following relations: In front is the pericardium and left pneumo-gastric nerve; behind, is the right pneumo-gastric nerve, the vena azygos major, some intercostal veins, the thoracic duct and, at its lower part, the thoracic aorta, its relations to which are as

follows: At its commencement it lies to the right of the aorta but at once inclines forward and to the left, so as to get in front; so that at its termination it is in front of the aorta and to the left. On each side it is in contact with the pleura.

Structure.

The œsophagus consists of three coats, a mucous and two muscular. The muscular coats are external longitudinal and internal circular. The longitudinal fibres are uniformly diffused around the tube through most of its extent, but above are gathered into three more or less distinct bundles; that in front attached to the cricoid cartilage and the others continuous with the pharynx; below, this coat becomes continuous with the stomach. The circular fibres above are continuous with the inferior constrictor of the pharynx and below with the stomach. This coat is separated from the mucous membrane of the œsophagus by a sub-mucous connective tissue sometimes called the areolar coat of the œsophagus. The fibres of both muscular coats are, above, reddish and distinctly striated, but below are pale and lose the striation.

The mucous membrane is loose and thrown into longitudinal folds when the tube is not distended. It presents numerous minute orifices of the ducts of the œsophagal glands which lie embedded in the sub-mucous tissue.

The Abdominal Viscera.

The cavity of the abdomen is bounded above by the diaphragm, which is a thin arched muscle with its cavity downwards, forming the floor of the chest and the roof of the abdomen. The floor of the abdomen is the floor of the pelvis, *i. e.* the structures which close the outlet of the pelvis. Occasionally the floor is given as the brim of the true pelvis and the iliac fossæ, the true pelvis being then considered a separate cavity. Laterally and in front, from the lower ribs above to the ilium below, the abdominal wall is formed of soft tissues, muscles, &c., and is the soft, fleshy, front wall of the belly. At its upper part the cavity is partly circumscribed by the lower ribs—the last six or seven; below, by the bony wall of the pelvis; behind, by the lumbar portion of the vertebral column; while on each side are, above, the floating ribs, below, the pelvic wall, and, between the two, the soft tissues. For convenience of description the abdomen is arbitrarily divided into three zones, and each of these into three regions, by two horizontal and two vertical imaginary lines. The upper horizontal line is drawn between the extremities of the ninth ribs; the lower between the anterior superior spinous processes of the ilia. The vertical lines, one on each side, are projected upward from the centre of the fold of the groin.

The names of the nine regions are as follows: The central region in the upper zone is the epigastric, the one on either side hypochondriac, right and left; the central region in the middle zone is the umbilical, the one on either side lumbar, right and left; the central region in the lower zone is the hypogastric, the one on either side, iliac, right and left.

The contents of the abdomen are the greater part of the alimentary canal, the accessory organs of digestion—liver, spleen and pancreas—and the genito-urinary organs—kidneys and supra-renal capsules, the bladder and its appendages, prostate gland, seminal vesicles and vas deferens. The testicles are considered with the abdominal viscera, although, in the adult, lying in the scrotum, outside the abdominal cavity. In the female there are the uterus and its appendages and the vagina. Enveloping most of these organs, and lining the walls of the cavity, is a serous membrane, called the peritoneum. The following are the portions of the alimentary canal contained in the abdomen: 1st, the stomach; 2d, small intestine; 3d, large intestine. The stomach is the dilated part which succeeds the œsophagus and is about twelve inches long. It terminates, about the line which separates the epigastric from the right hypochandriac region in the small intestine. The small intestine is divided into three parts, duodenum, jejunum and ileum. The duodenum is about nine inches long; the jejunum and ileum, together about twenty feet, the jejunum comprising the upper two-fifths and the ileum the lower three-fifths. The duodenum is again subdivided into three portions, viz: first portion, ascending, or oblique duodenum, is about two inches long and terminates at the neck of the gall bladder, on the lower surface of the liver, in the right hypochondriac region in the second portion, called the descending, or perpendicular duodenum, which passes vertically downward for about three inches into the right lumbar region, about on a level with the upper border of the fourth lumbar vertebra, where it terminates in the third portion called the transverse duodenum, which is rather more than three inches long and crosses the front of the vertebral column obliquely upward and terminates at the left side of the body of the second lumbar vertebra, in the jejunum. The large intestine is subdivided into three portions called cœcum, colon and rectum. The cœcum is the commencing two and one-half inches, lies on the right iliac fossa and terminates in the colon at the opening of the small intestine. The colon is divided into the ascending, transverse and descending colon and the sigmoid flexure. The ascending passes upward through the right lumbar region into the right hypochondriac. At the under surface of the liver it curves sharply to the left, forming the hepatic flexure of the colon, and becomes the transverse colon. The transverse colon passes downward

and to the left, crosses the abdomen between the epigastric and umbilical regions and rising into the left hypochondriac region forms another abrupt curve at the lower end of the spleen, called the splenic flexure of the colon, and becomes the descending colon. The descending colon passes downward through the left lumbar region into the left iliac where it becomes the sigmoid flexure. The sigmoid flexure is formed by the gut's passing upward and to the right and then downward and to the left to terminate at the brim of the pelvis on the left side, in front of the left sacro-iliac symphysis, by becoming the rectum. The colon is about four feet in length. The rectum is the last eight inches of the large intestine and terminates the alimentary canal at the anus, about the middle of the floor of the pelvis. The liver lies in the upper zone of the abdomen, stretching nearly across the cavity just beneath the roof. The spleen is in the left hypochondriac region. The pancreas lies transversely behind the stomach, between the spleen and perpendicular duodenum, crossing the front of the body of the first lumbar vertebra. Each of the two kidneys is beside the lumbar portion of the spinal column, on the front of the posterior abdominal wall. The urinary bladder and its appendages are found in the pelvis just behind the os pubis. The uterus and vagina, in the female, are interposed between the rectum and bladder.

Reflections of the Peritoneum.

The peritoneum, being a serous membrane, is a closed sac, one layer covering the viscera, and called the visceral layer, and the other lining the walls and called the parietal layer. The existence of the peritoneum renders the motions of the viscera upon one another, and upon the abdominal walls, easy and harmless and furnishes bonds of connection between them and the walls of the containing cavity. Being a closed sac its continuity can be demonstrated by the fact that in following it, transversely or vertically, it can be traced back to the point of departure. The folds it makes from above downward are the most important and will be first stated.

It leaves the lower surface of the diaphragm in two layers, which pass to the upper and lower edge of the posterior border of the liver. The upper layer covers the upper surface of the liver, curves around the anterior border and coats the lower surface as far back as the transverse fissure, where it meets the lower layer, which has covered the lower surface from the posterior border to the transverse fissure. The two layers, having thus enveloped the liver, leave it at the transverse fissure and pass downward to the stomach, forming between these two organs the gastrohepatic omentum, or the lesser omentum. They reach the stomach at its

upper border and divide, one passing over the front and one over the back, and meet again at the lower border after furnishing a coat to the stomach. The two layers leave the stomach at its lower border and pass downward to the transverse colon, passing over it without touching and descend almost to the brim of the pelvis, just behind the anterior abdominal wall; they then reverse their course, run upward, just posterior to their descending course, reach the transverse colon, and, separating, enclose it. That part of the peritoneum extended between the lower border of the stomach and the transverse colon is called the greater omentum. The two layers, having enveloped the transverse colon, meet at its posterior border and pass back to the posterior abdominal wall, where they form the transverse mesocolon, which loosely holds the transverse colon to the posterior abdominal wall. The two layers now finally separate; one goes up the posterior abdominal wall to the lower surface of the diaphragm, where its course was first taken up, thus partially enclosing a space behind the stomach called the lesser cavity of the peritoneum, which communicates with the general cavity through an opening behind the oblique duodenum, called the foramen of Winslow; the other layer passes forward to envelope the coils of the jejunum and ilium and returns to the posterior abdominal wall, forming a double layered fold, holding the intestine to the abdominal wall, called the mesentery. The attachment of the mesentery is thus stated: from the left side of the body of the second lumbar vertebra downward and to the right to the right sacro-iliac synchondrosis. After forming the mesentery the peritoneum descends the posterior abdominal wall to the brim of the pelvis passes down its posterior wall, covering the upper half of the rectum completely, leaves the front of the rectum an inch below its middle, strikes the back part of the base of the bladder, in the male, covers the back, sides and posterior half of the top of the bladder, and leaves the bladder to mount on the posterior face of the anterior abdominal wall and pass up it and reach its starting point on the lower surface of the diaphragm. In the female, when the peritoneum leaves the front of the rectum, it passes to the lower wall of the vagina, covering its upper inch, then strikes the uterus passing up its back and turning down its front whence it passes to the bladder. In mounting over the top of the uterus it also passes over the ovary and its ligament, on each side, thus forming on each side a double layered fold stretching between the sides of the uterus and the lateral walls of the pelvis called the broad ligament of the uterus. Between these two layers are the ovary and its ligament, the round ligament of the uterus and the fallopian tubes.

Followed transversely around the abdomen, about its middle, the peri-

toneum presents the following folds: commencing on the anterior abdominal wall it can be followed to the posterior abdominal wall, where it reaches the descending colon and passes over it, covering it from half to three-fourths around; and, leaving it at a corresponding line on the inner side, it reaches the vertebral column where it turns forward to envelope the folds of the jejunum and ilium and to pass back on itself to the vertebral column, forming the mesentery; it then runs out on the posterior abdominal wall to reach the ascending colon, passes over its front, covering it from half to three-fourths around, and, leaving it, reaches the abdominal wall again along which it runs to the place of departure.

Relations of the Abdominal Viscera—

Stomach.

The stomach lies in the upper zone, in the left hypochondriac and epigastric regions, generally terminating in the duodenum on the line which separates the epigastric from the right hypochondriac region, but occasionally passing more or less into the latter. Its long axis is directed from above downward, from left to right and from behind forward; one surface looks forward, the other backward; one border, the shorter, or lesser curvature, upward, the other, the long, or greater curvature, downward; the large end is to the left, the small, to the right. It is continuous with the duodenum at the right end. Its upper border is held to the lower surface of the liver by the lesser omentum; its lower border is indirectly held to the transverse colon by the greater omentum; its left end is connected with the spleen by the gastro splenic omentum. Above it are the diaphragm and the left lobe of the liver; below is the transverse colon; to the right it is continuous with the duodenum; to the left is the spleen; behind are the pancreas and left kidney; in front, the anterior abdominal wall and part of the left lobe of the liver. It has a complete peritoneal coat.

The Oblique Duodenum.

The oblique, or ascending duodenum, commences at the right extremity of the stomach, usually on the line which separates the epigastric from the right hypochondriac region, and passes upward and to the right, in the latter region, to terminate in the descending duodenum at the neck of the gall bladder on the lower surface of the liver. It lies in the right border of the lesser omentum and has behind it the hepatic artery, the common bile duct and the portal vein. In front of it is the liver. It is completely invested by peritoneum.

The Perpendicular Duodenum.

The perpendicular, or descending duodenum, commences at the termination of the oblique duodenum, at the lower surface of the liver, at the end of the gall bladder in the right hypochondriac region, and descends vertically into the lumbar region to terminate in the transverse duodenum, about on a level with the upper border of the fourth lumbar vertebra. It lies behind the peritoneum, being covered by it only in front. Behind it has the right kidney and in front the ascending colon; to the left it is adherent to the head of the pancreas.

The Transverse Duodenum.

The transverse duodenum commences where the oblique terminates, in the right lumbar region, on a level with the upper border of the body of the fourth lumbar vertebra, and passing upward and to the left, across the body or the third lumbar vertebra, terminates in the jejunum at the left side of the body of the second lumbar vertebra. It lies behind the peritoneum, between the diverging layers of the transverse meso-colon, so that it is covered by peritoneum only in front. Above it is the lower border of the pancreas, from which it is separated by the superior mesenteric artery and vein; in front is the transverse colon.

The Jejunum and Ileum.

The remaining twenty feet of the small intestine, following the duodenum, are thrown into coils called the convolutions of the small intestine, and are found chiefly in the umbilical and hypogastric regions, falling off, however, into surrounding regions, some being always found in the pelvis between the rectum and bladder in the male and the rectum and uterus in the female. The jejunum comprises the upper two-fifths of the intestine and begins where the duodenum terminates, at the left side of the body of the second lumbar vertebra. The ileum is the lower three-fifths, and terminates in the right iliac region by opening into the large intestine two and one-half inches above its commencement.

The convolutions are completely enveloped by the peritoneum, which holds them by a double-layered fold to the posterior abdominal wall. In front they are separated from the anterior abdominal wall by the great omentum; above is the transverse colon; to the right the ascending, to the left, the descending colon.

The Cœcum.

The cœcum is the commencement of the large intestine. It is two and one-half inches long and terminates in the colon at the opening of the small intestine. It lies in the right iliac fossa or region, and is generally completely invested by peritoneum. Attached to it is the vermiform appendix, a blind tube about the size of a goose quill and from four to six inches long. It opens into the inner back wall of the cœcum, just below the opening of the ileum, and not into the bottom. The appendix has a complete peritoneal coat and lies slightly coiled on the inner side of the cœcum and just below the ileum.

The Ascending Colon.

The ascending colon commences where the cœcum terminates, in the right iliac region, at the opening for the ileum, and passes upward through the right lumbar region into the right hypochondriac region where it terminates by becoming the transverse colon, forming the hepatic flexure of the colon at the lower surface of the right lobe of the liver, to which it is held by a fold of the peritoneum, being covered by it in front from half to three-fourths around. In front and to the outer side is the abdominal wall; to the inner side, the convolutions of the small intestine; behind, the perpendicular duodenum and right kidney.

The Transverse Colon.

The transverse colon commences at the termination of the ascending colon, at the lower surface of the liver, in the hepatic flexure of the colon, and passes obliquely downward and to the left, crosses the abdomen between the upper and middle zones, and, rising into the left hypochondriac region, terminates by forming the splenic-flexure of the colon at the lower end of the spleen and becomes the descending colon. Its course is curved with its convexity downward and forward. It is entirely covered by peritoneum, which holds it by a long double-layered fold, the transverse meso-colon, to the posterior abdominal wall and by a small band to the lower end of the spleen. It is indirectly held to the greater curvature of the stomach by the great omentum. In front it is separated from the anterior abdominal wall by the great omentum; behind is the transverse duodenum; above are the liver, stomach and spleen; below, the convolutions of the small intestine.

The Descending Colon.

The descending colon begins where the transverse colon ceases, in the left hypochondriac region at the lower end of the spleen, and passing downward through the left lumbar region terminates in the left iliac region by becoming the sigmoid flexure of the colon. It lies behind the peritoneum, covered by it in front from half to three-fourths around. To its front and outer side is the abdominal wall; behind, the left kidney; to the inner side are the convolutions of the small intestine.

The Sigmoid Flexure.

The Sigmoid flexure of the colon begins at the termination of the descending colon, in the left iliac region, and curves upward and to the right and then downward and to the left to become the rectum at the brim of the pelvis in front of the left sacro-iliac symphysis. It is completely invested by peritoneum, which holds it to the iliac fossa by a long fold which permits it to fall in different directions.

The Rectum.

The rectum commences at the termination of the sigmoid flexure of the colon in front of the left sacro-iliac symphysis and passes first downward and to the right, to the middle of the front of the sacrum, then down the front of that bone to a point opposite the tip of the coccyx, where it turns slightly backward, and after a course of about an inch, ends at the anus. Its upper half is entirely covered by peritoneum, which holds it to the pelvic wall. Its lower half is covered by peritoneum only for an inch in front at its upper part; in other words, it is three inches from the anus to the peritoneum in front and four inches behind. Behind the rectum is the pyriformis muscle, the sacral plexus of nerves and the left internal iliac vessels; in front, from above downward, in the male, are the bladder and its appendages, in the female, the uterus and vagina. Interposed between it and the bladder, or uterus, are some convolutions of the small intestine.

The Liver.

The liver is found in the upper zone of the abdomen, the greater part being in the right hypochondriac and epigastric regions, but projecting, to a greater or less extent, into the left hypochondriac. Its long axis is transverse; its sharp notched border is in front and below, nearly corresponding to the lower margin of the ribs on the right; its thick border

is backwards, resting against the diaphragm and grooved for the inferior vena cava, and also, near the left end, for the œsophagus; its convex surface is above; its large end is to the right.

It is held in place by five ligaments and is connected to the stomach by the lesser, or gastro-hepatic omentum. Four of its ligaments are ormed by the peritoneum while the fifth, called the round ligament, is the remains of the obliterated umbilical vein. The peritoneum reaches the liver by two very short layers, which seize the one the upper the other the lower edge of its posterior border. These layers, on the posterior border, are separated by a considerable triangular space; but at each end they come together and form the right and left lateral ligaments. Between these lateral ligaments the layers surrounding the triangular space form the coronary ligament. The upper layer is diverted forward from the liver, at a point about one-third the length of the liver from its left end, across the upper surface of the liver so as to surround the round ligament by a double-layered fold called the suspensory ligament, or the longitudinal ligament, which holds the liver to the diaphragm. The round ligament is that part of the obliterated umbilical vein which passes backward from the anterior abdominal wall to the notch in the anterior border of the liver, lying between the two layers of the longitudinal ligament. The peritoneum reaching the liver in the manner described, passes over it, one layer over the upper surface, around the anterior border to the transverse fissure where it meets the other layer, which has run forward on the lower surface from the posterior border, thus furnishing an almost complete peritoneal coat for the organ.

Above the liver is the diaphragm; below it are, from right to left, the right kidney with its supra-renal capsule, in front of these the hepatic flexure of the colon, behind, and to the left of this, the oblique duodenum, then the stomach, and lastly, the spleen, which is only an occasional relation.

The Spleen.

The spleen is confined to the left hypochondriac region. Its long diameter is vertical; its thin notched border is anterior; its smallest end is below; its convex surface, external. It has a complete peritoneal coat and is held in position by folds of peritoneum, one fold, called the suspensory ligament, passing from its upper end to the diaphragm, the other, called the gastro-splenic omentum, passing from its inner face to the great end of the stomach. A third small fold extends from its lower end to the splenic flexure of the colon.

Above it is the diaphragm from which it is sometimes separated by the liver; below is the splenic flexure of the colon; behind the lower end is

the left kidney and its capsule; in front, the anterior abdominal wall; internal to it are the great end of the stomach and the tail of the pancreas; externally it corresponds to the ninth, tenth and eleventh ribs, from which it is separated by the diaphragm, the left pleura and the lower border of the left lung.

The Pancreas.

The pancreas extends from the inner face of the spleen on the left to the descending duodenum on the right. Its long diameter is transverse; its large end to the right; one surface looks forward, the other backward; one border is above, the other below.

It rests on the front of the posterior wall of the abdomen, crossing the body of the first lumbar vertebra. It is behind the peritoneum, which covers it only in front. To its right is the perpendicular duodenum, to which it is closely adherent; to its left is the inner face of the spleen to which its tail is held by the peritoneum; in front is the stomach; behind its left end is the left kidney; below it is the transverse duodenum, from which it is separated by the superior mesenteric vessels. Its relations to blood vessels are very complex, and may be given as follows: it is separated from the vertebral column by the abdominal aorta, which produces the cœliac axis on a level with the upper border of the head of the pancreas while the superior mesenteric artery is emitted just behind the head; the latter descending behind the pancreas, to pass out between it and the transverse duodenum.

The cœliac axis, resting on the upper border of the head of the pancreas, divides into three branches, one of which, the splenic, pursues a a very tortuous course along its upper border to the inner face of the spleen. This artery is accompanied by its vein, which passes to the right from the spleen, lying in a deep groove on the posterior face of the pancreas just below its upper border. Behind the head of the pancreas the splenic vein unites with the superior mesenteric vein, which ascends behind the pancreas as the companion of its artery, the two veins forming the portal vein. About the middle of its course the splenic vein receives the inferior mesenteric vein which passes behind the body of the pancreas. Surrounding the cœliac axis are the two semi-lunar ganglia of the sympathetic, giving off the numerous branches of the solar plexus of nerves, which are in close relation with the head of the pancreas.

The Kidneys.

The kidneys lie on the front of the posterior abdominal wall, extending from about the eleventh rib downward and slightly outward to about

the crest of the ilium. The right is perhaps a little lower than the left, reaching only to the lower border of the eleventh rib while the left reaches to its upper border. The kidneys correspond to the last dorsal and the upper three lumbar vertebræ. They lie behind the peritoneum, embedded in a considerable mass of loose connective tissue, which usually contains much fat. The peritoneum is loosely connected to the front of the organ by this tissue and can easily be stripped off. The long diameter of the kidney is from above downward and slightly outward; one face looks forward and slightly outward, the other backward and slightly inward; the upper end is, perhaps, the larger; the outer border is convex, the inner, concave. Through most of its extent the kidney rests on the quadratus lumborum muscle, separated from it by the anterior lamella of the posterior aponeurosis, of the transversalis muscle. Along its inner edge it lies on the psoas magnus muscle, and behind its upper part is the diaphragm, which separates it from the pleura. The diaphragm here frequently presents a fissure of considerable size, where the muscular tissue is wanting, so that, in this event, all that separates the kidney from the pleura is a little loose connective tissue. Each kidney has upon its upper inner front part the supra-renal capsule. The outer border is nearly opposite the outer border of the erector spinæ muscle, and about corresponds to the junction of the posterior third with the anterior two-thirds of the crest of the ilium.

The right kidney has in front the descending duodenum and in front of that the ascending colon; along its inner border is the ascending vena cava; its upper end is in contact with the lower surface of the liver, which may also rest on the front of its upper part. The left has on its front the descending colon and, at its upper part, the lower end of the spleen the tail of the pancreas and the great end of the stomach.

The Bladder, in the Male.

The urinary bladder occupies the front portion of the pelvic cavity, being confined to it when empty or nearly so, but rising out of it according to its state of distension, occasionally reaching the level of the umbilicus. It lies just behind the symphysis pubis with its long diameter from above downward and backward, extending from the upper border of the symphysis pubis, or a point in the linea alba between it and the umbilicus, varying with distension, so that, if prolonged, it would strike the lower part of the front of the sacrum.

The large end of the bladder is below and looks downward and backward. The viscus is retained in position by its ligaments which are ten in number. Five of these are called false ligaments and are furnished by

peritoneum, while of the five true ligaments four are processes of fascia and one is the remains of a fœtal structure, called the urachus.

The peritoneum leaves the front of the rectum about three inches above the anus, and sweeps in a drooping course to the back part of the base of the bladder. This broad fold, extending from the front of the rectum to the bladder, is spoken of as the two posterior false ligaments. The division between them is purely arbitrary, being the middle line of the body. On each side, however, the fold presents an antero-posterior ridge, produced by the passage of the hypograstic artery from the posterior side of the pelvic wall to the side of the lower part of the bladder, the artery then passing up the side of the back of the bladder to the side of the top, whence it leaps to the anterior abdominal wall and approaching its fellow of the opposite side, makes for the umbilicus. In fœtal life, this artery carries impure blood from the fœtus to the placenta, emerging at the umbilicus; after birth it becomes impervious from the umbilicus to the bladder, but from that point back to its origin from the internal iliac it transmits some blood to the bladder.

The peritoneum, reaching the bladder, covers the back part of its base, the back of the bladder, the posterior half of each side and the posterior half of the top, thence passing to the anterior abdominal wall, to which it is guided by the urachus and the obliterated hypogastric arteries. That part of the peritoneum extending from the middle of the top of the bladder to the anterior abdominal wall is called the superior false ligament; and that part on each side, extending from the side of the bladder to the lateral wall of the pelvis, forms the lateral false ligament.

The four remaining true ligaments are formed by the pelvic fascia, which lines the pelvic cavity just beneath the peritoneum. From either side of the symphysis pubis a process of this fascia is extended to the lower part of the front of the bladder and prostate gland, these two being called the two anterior true ligaments of the bladder. From the lateral wall of the pelvis, on each side, a process of fascia passes to the side of the bladder, the two being known as the two lateral true ligaments of the bladder.

The front of the bladder is separated from the back of the symphysis pubis only by a little loose connective tissue. The neck of the bladder is received into the back part of the prostate gland and is continuous with the urethra, being about an inch behind and below the pubic arch.

The posterior face of the bladder is separated from the rectum usually by some convolutions of the small intestine. The base of the bladder rests on the front of that part of the rectum which is found descending

the front of the sacrum, usually called the second portion of the rectum and is adherent to it. Piercing the posterior part of the base of the bladder on each side is the ureter, the two being about two inches apart each having just internal to it the vas deferens, which, entering the abdomen at the internal abdominal ring passes to the side of the top of the bladder, descends to its posterior face runs forward and inward along its base to terminate at the front of the base by uniting with the duct, which forms the seminal vesicle to produce the ejaculatory duct. The seminal vesicles lie, one on each side, on the side of the base of the bladder. They are pear-shaped, the base being behind and the apex forward and inward at the back of the prostate gland. In the female the bladder, in general terms, occupies the same position as in the male. There are no prostate glands, no vas deferens or seminal vesicles. The base of the female bladder rests on the upper wall of the vagina, and on the lower part of the front of the uterus, which two separate it from the rectum. Otherwise the relations are about the same as in the male.

The Stomach.

In shape the stomach is a curved cone, with one border shorter than the other and its two sides, called anterior and posterior faces, somewhat flattened. The short border is known as the lesser curvature, the long as the greater curvature. The large end of the cone is to the left and is called the splenic end, because it is hugged by the spleen. At the left extremity of the lesser curvature, two or three inches from the left end, is an aperture for the œsophagus, called the cardiac orifice. The splenic end of the stomach is the dilated cul de sac bulging beyond this.

The right extremity of the stomach is much smaller than the splenic end and is called the pyloric extremity, because the opening of this end of the stomach in the duodenum is called the pylorus. It is the smallest part of the alimentary canal, being only an inch and a half in diameter. The position of the stomach is not directly transverse, but somewhat oblique, its long diameter being from above *downward*, *forward*, and to the *right* the cardiac orifice being on a higher level and farther back than the pyloric. When empty, the anterior and posterior faces look almost directly forward and backward respectively.

The longest diameter of the stomach is about twelve inches, and it receives from one to two quarts of food at a time.

The Duodenum.

The duodenum succeeds the stomach. It is about nine inches in

length and forms a horseshoe-shaped curve whose convexity is to the right. It is divided into three portions. The first portion, beginning at the stomach, is about two inches in length and is called the oblique portion. It passes upward, backward and to the right. The second portion, called the descending or perpendicular duodenum, is about three inches long and passes downward. The third portion, called the transverse duodenum, begins where the descending terminates and passing across the vertebral column, terminates in the jejunum, or second portion of the small intestine. The duodenum terminates at the left side of the second lumbar vertebra; but the point where the jejunum becomes the ileum is arbitrary and ill defined. The jejunum begins where the duodenum terminates and comprises the upper two-fifths of the remainder of the gut. The ileum comprises the remaining three-fifths and terminates in a suddenly dilated portion called the large intestine. The jejunum and ileum together are about twenty feet long. They lie coiled up chiefly in the umbilical and hypogastric regions, producing an appearance somewhat similar to the upper surface of the brain, from which they are called the convolutions of the small intestine.

The large intestine begins by a sudden dilation just below the termination of the small intestine in the right iliac region, and extends to the termination of the alimentary canal at the anal orifice.

The large intestine is about five feet in length. It is sinuous in its course and is divided into three portions, cœcum, colon and rectum.

The entrance of the ileum is not into the extremity of the large intestine but two or three inches above its commencement. The blind pouch or cul de sac, which extends below this orifice is called the cœcum. This is the largest portion of the large intestine; it is about two and a half inches in length, lies in the right iliac fossa, is continuous with the colon above and has projecting from its lower, inner back part a tail-like hollow projection called the vermiform process, or appendix, which is from four to six inches in length and lies just below the terminal part of the ileum, its cavity being continuous with that of the cœcum.

The colon is the second portion of the large intestine. It commences at the entrance of the ileum, which is the mark of division between it and the cœcum, in the right iliac region, and passes upward through the right lumbar region to the lower surface of the liver, in the right hypochondriac region. This portion of the gut is called the ascending colon. At the lower surface of the liver it makes a bend called the hepatic flexure of the colon, and turns to the left across the abdominal cavity. This portion is called the transverse colon and its course corresponds to the superior horizontal line of the abdomen. At the lower end of the spleen,

in the left hypochondriac region, the colon makes another bend, called the splenic flexure, and turns downward to pass through the left lumbar region to the left iliac fossa, as the descending colon. In the left iliac fossa it makes another turn, first upward and to the right and then downward and to the left, forming the sigmoid flexure, which terminates at the brim of the pelvis, opposite to the left sacro-iliac symphysis, in the rectum. The rectum begins where the sigmoid flexure terminates and passes downward on the front of the sacrum, to terminate at the anus, being approximately straight in its course—hence its name.

Structure.

The following coats, with slight exceptions, are common to the whole of the alimentary canal found in the abdomen:

1st. The visceral layer of the peritoneum.

2d. The interior coat is mucous membrane.

3d. Between these two are found the longitudinal muscular fibres, lying next to the serous coat, and

4th. The circular, next to the mucous coat.

These coats are held to one another by interposed connective tissue, or areolar tissue. Each part, also, presents some point, peculiar to itself.

The stomach has, 1st, the serous coat which, besides investing it, passes off to adjoining parts forming the omenta of the stomach which seem to retain it in its position. It is held to the liver by the gastro-hepatic, or lesser omentum, to the spleen by the gastro splenic omentum and to the transverse colon by the gastro-colic, or greater omentum.

2d. Just beneath the serous coat is the longitudinal muscular coat.

3d. Just beneath this is the circular muscular coat, which is thickest toward the pyloric extremity, while the longitudinal is thickest at the lesser curvature. The fourth coat is a partial one, of oblique muscular fibres which diverge from the cardiac end of the stomach beneath the circular fibres and terminate before reaching the pyloric orifice. The fifth coat is the internal mucous coat, which, when the stomach is empty, is thrown into longitudinal ridges, called rugæ, which disappear when the stomach is distended. At the pylorus the mucous coat is thickened, and beneath this thickening is an aggregation of the circular fibres so as to produce a sudden contraction of the tube. This appearance is known as the pyloric valve.

The duodenum has four coats: 1st, serous; 2d, longitudinal muscular; 3d, circular muscular; 4th, mucous membrane. In the commencement of the gut the mucous membrane is smooth, but it is soon thrown into folds, which pass around the gut from three-fourths to five-sixths of its

circumference; called valvulæ conniventes. These valvulæ conniventes are continued down into the jejunum and ileum, but gradually decrease in size and in the ileum are inconspicuous. They are permanent folds, not affected by distension.

On the lower inner part of the perpendicular duodenum is a prominence of the mucous membrane, called a papilla, on which is seen the aperture for the common bile duct and the pancreatic duct.

The jejunum and the ileum have the same coats, in the same order, as the duodenum. Studding the inner surface of the small intestine are numberless hair-like microscopic projections from the mucous membrane called villi; and besides these, and numerous mucous follicles which have their seat throughout the small intestine, there are some glandular bodies which have special seats.

In the duodenum there are numerous small glands, about the size of a pin's head, lying just beneath the mucous membrane and opening by ducts on its free surface, known as the glands of Brunner. Scattered throughout the small intestine, but much more numerous in the lower part of the ileum, are small, round, grayish bodies, in the mucous membrane, which have no duct and are called solitary glands. In the lower part of the ileum, and extending upward ten feet, or more—in a few instances into the duodenum—are found a number of dark, oblong, grayish patches, called Peyerian glands or Peyer's patches. They are twenty to thirty in number. Sometimes there are as many as forty. The long diameter of these patches is in the direction of the gut. They are made up of an aggregation of the solitary glands and becomes diseased in typhoid fever.

The opening of the small intestine into the large is by means of a horizontal slit-like opening, situated on the inner side of the large intestine two and a half inches above its commencement, and guarded by a valvular arrangement called the ileo-cœcal, or ileo-colic valve. This valve consists of two projections into the cavity of the large intestine, one above and the other below the button-hole like aperture, each segment being a fold of mucous membrane covering circular fibres of muscular tissue.

The large intestine, like the small, has four coats, external serous, internal mucous and between these two muscular, outer longitudinal, inner, circular. From the commencement of the gut to the rectum the longitudinal coat is not distributed uniformly around the gut, but the fibres are gathered into three narrow flat bands placed one in front, one on the back and one on the concave, inner side of the gut. These bands are shorter than the other coats of the gut, and in consequence the other

tunics are thrown into folds with corresponding depressions. These prominences are known as the saculi of the large intestine. Towards the termination of the colon these bands begin to be diffused, and in the rectum the longitudinal fibres are again distributed and of equal length with the other coats. The mucous membrane, in consequence of the shortness of the longitudinal muscular fibres, is also thrown into saculi. Beneath it, especially in the upper part of the gut, are seen a number of solitary glands which differ from those in the small intestine in having a duct.

The rectum presents some important departures from the above description. It is usually divided into three portions. The first portion extends from the commencement of the gut until it ceases to incline to the right, that is until it reaches the mid line of the sacrum opposite the front of the body of the third sacral vertebra; the second, from this point to one opposite the tip of the coccyx; the third is the last inch of the gut, which here inclines backward to terminate at the anus. The rectum presents the same four coats, in the same order, with the following exceptions: The serous coat is a partial one, the upper half of the gut being entirely surrounded by peritoneum while the lower half is covered by it for only an inch at its upper front part, from which point it mounts to the bladder. The fibres of the longitudinal muscular coat become much more distinct, and of a reddish color, in the lower part of the gut; and, when they reach its extremity, they do not stop short, but turn upward to run along the inner face of the circular fibres, which separate them from the descending longitudinal fibres, while the mucous membrane lies between them and the cavity of the gut. These ascending longitudinal fibres are gathered into separate bundles, or columns, which pass up for an inch or two before ceasing and throw the mucous membrane into ridges with intervening depressions called rectal pouches. Towards the lower extremity of the rectum the fibres of the circular muscular coat are aggregated into a thickened ring, internal sphincter ani, and just above this the cavity of the gut is considerably dilated, forming a capacious reservoir in cases of long continued constipation.

The Liver.

The liver stretches across the abdomen just beneath its roof, lying in the right hypochondriac, the epigastric and to some extent, the left hypochondriac region. It is semi-ovoidal in shape, weighs about four pounds, is about twelve inches long, six broad and three thick, at its thickest part; in color it is a dull red with, occasionally, a purplish, or yellowish tinge. It is, in structure, a solid glandular organ. For study

it is divided into an upper and a lower surface, an anterior and a posterior border, five ligaments and an excretory apparatus.

The upper surface is smooth and convex, being moulded on the lower surface of the diaphragm. It presents a glistening appearance due to the visceral layer of peritoneum, which has been traced. The peritoneum, passing from the diaphragm to the liver in an antero-posterior fold, strikes the liver nearer the left than the right extremity. This fold, the longitudinal ligament, is a mark of division between the two lobes, all that portion lying to the right being known as the right lobe, while the much smaller portion, lying to the left is the left lobe.

The anterior border is thin and sharp and has a notch at the point where the longitudinal ligament intersects it, which also marks the division between the lobes. The anterior border is just above the lower border of the ribs, though, when the liver is enlarged, it may be felt through the abdominal parietes.

The posterior border is thick and rounded and marked by a notch where it is intersected by the longitudinal ligament, a third mark of division between the two lobes. The openings for the hepatic veins are found on this border, and it is grooved for the inferior vena cava.

The lower surface is marked from before backwards by a fissure called the longitudinal, which is just opposite the longitudinal ligament on the upper surface, and extends from the notch in the anterior to that in the posterior border. It is the fourth mark of division between the lobes. The lower surface of the right lobe presents a deep groove, called the transverse fissure, which runs to the right from the longitudinal fissure which it strikes about at its posterior third. In this fissure are found the hepatic duct to the right and slightly in front, the hepatic artery to the left and between and behind the two the portal vein. That portion of the longitudinal fissure which is behind the intersection of the transverse fissure, is called the venosus fissure, and the portion in front the umbilical fissure. The latter is frequently crossed by a strip of liver tissue, called the pons hepatis. Lying in front of the transverse fissure, and producing an impression on the lower surface of the right lobe, is the gall bladder; and between this and the longitudinal fissure is a square-shaped portion of liver tissue called the lobus quaratus, whose limits are, in front, the anterior border of the liver, behind, the transverse fissure, to the right the gall bladder, to the left the longitudinal fissure. Behind the transverse fissure is another portion of liver tissue, which has received the name of lobus Spigelii. It is three sided, having in front the transverse fissure, to the left the venosus portion of the longitudinal fissure and to the right the groove made by the inferior vena cava.

Running out to the right from the front of the lobus Spigelii, just behind the transverse fissure, is a ridge, called the lobus caudatus. Near the posterior border there is a depression on the lower surface of the right lobe made by the right kidney and its suprarenal capsule.

The liver is held in position by processes of peritoneum, called ligaments, which are five in number.

The longitudinal, or suspensory ligament consists of two layers of peritoneum which pass from the lower surface of the diaphragm to the upper surface of the liver. These two layers separate on reaching the liver and, with two exceptions, completely invest it. One exception is the space on the lower surface, occupied by the gall bladder, for the peritoneum leaps over the gall bladder, investing it, and leaves the contiguous surfaces of gall bladder and liver uninvested. The other exception is found at the posterior border, for the two layers here diverge, to form the right and left lateral ligaments, which are nothing more than the points where the visceral and parietal layers come in contact; and between the two diverging layers, on the posterior border, there is a triangular space which has no serous coat. The two layers, as they skirt this space, are known as the coronary ligament. The fifth ligament is found as a rounded cord in the front edge of the longitudinal ligament. It is the obliterated umbilical vein.

The excretory apparatus consists of a series of ducts, and a reservoir, called the gall bladder.

The gall bladder is a membranous pyriform sac, lying on the lower surface of the right lobe of the liver, its large end lying forward and usually falling short of the anterior border, though occasionally projecting beyond it. Its small end lies backward and terminates at the transverse fissure in a neck which becomes continuous with a duct called the cystic. This duct is about one inch long and unites with the duct from the liver to form the common bile duct. The gall bladder has three coats. The external serous coat is only a partial one, since it passes over the gall bladder from the liver, leaving that portion next the liver uninvested. The next coat is fibro-muscular.

The internal coat is mucous, and, in the neck, it is thrown into a spiral fold, so that liquid in following the spiral can flow but slowly.

In the transverse fissure two ducts, one from the right and one from the left lobe, unite to form the hepatic duct, which is about two inches long and descends to unite with the cystic to form the common bile duct—ductus communis choledochus—which descends for about three inches to open on a papilla on the lower inner part of the perpendicular duodenum.

Structure.

The external investment of the liver is the nearly complete serous coat. Beneath this is a white fibrous coat which everywhere covers the liver, and gives off numberless processes which pass into the substance of the liver and divide it into minute subdivisions called lobules. These are made up of the proper liver substance.

In the transverse fissure are three sets of vessels which ramify in the liver to fulfil the following offices: 1st. The hepatic artery carries arterial blood to the liver. 2d. The portal vein also pours a stream of blood into the organ. 3d. The hepatic duct, resulting from the coalescence of the smaller ducts from the lobules, conveys the bile away from the liver.

When traced into the liver these vessels are found associated throughout the organ. The venous blood is removed from the liver by means of a fourth set of vessels called the hepatic veins, which result from ramifications associated with the other vessels but which open, by three, or four separate apertures, on the posterior border of the liver, into the inferior vena cava.

The Pancreas.

The pancreas is a pale, lobulated gland. It is six or seven inches long and varies in thickness from an inch and a half to less than half an inch. It weighs about three ounces and lies horizontally behind the stomach, with its large end or head embraced by the concavity of the descending duodendum, and its small end or tail in contact with the inner aspect of the spleen. It crosses the body of the first lumbar vertebra, which renders its posterior aspect concave whereas its anterior is convex. The head is much the larger portion of the organ and sends downward, at right angles to the rest of the organ, a considerable projection from which the gland has been likened to a hammer. The head also furnishes a prominence backward and to the left which is sometimes called the lesser pancreas, and is found lying behind the superior mesenteric vessels.

The Pancreatic Duct.

The pancreatic juice is collected and conveyed away by a duct called the pancreatic, or canal of Wirsung, which commences in the tail of the organ by a forked origin. The two branches soon unite and the resulting duct, as it passes to the right grows by momentary accessions until it reaches the right extremity of the organ, where it pierces the coats of the perpendicular duodendum to open on the papilla for it and the common bile duct.

Somewhere, just before leaving the pancreas, it receives the duct from the lesser pancreas.

In structure the pancreas is a lobulated gland. It lies behind the peritoneum, and, consequently, has a serous coat only in front.

The Spleen.

The spleen lies vertically in the left hypochondriac region. It is completely invested by peritoneum, which forms two folds to retain it in position. The first is called the suspensory ligament and suspends the spleen by its upper extremity to the lower surface of the diaphragm; the second, the gastro-splenic omentum passes between the inner surface of the spleen, and the contiguous large end of the stomach.

In color the spleen is a dark red, in shape, semi-ovoidal, in consistence, extremely fragile, in size, about six inches long, three broad and one and a half thick, in weight, about seven ounces. It may be divided, for study, into two surfaces, two borders and two extremities. The external face is convex to correspond with the sweep of the abdominal wall; the internal, flat, or perhaps, concave, to hug the great end of the stomach, and marked about its centre by a vertical groove, called the hilum, where the branches of the splenic artery find ingress and the vein egress, and where the gastro-splenic omentum is attached. The upper extremity is much larger than the lower, which is thin and pointed. The posterior border is thick and rounded; the anterior, thin, sharp and marked by one or more notches.

Structure.

The spleen is invested by two coats, an external serous and, beneath this, a fibro-elastic coat, from the inner face of which are sent off processes, or trabeculæ, in the interspaces of which are found the proper splenic tissure or parenchyma, or splenic pulp. The spleen is a blood vascular, or ductless gland, and whatever it elaborates is carried off without the aid of a special apparatus.

The Kidneys.

The kidneys are a pair of organs found, one on each side of the vertebral column in the lumbar region, the left extending from the upper border of the eleventh rib to the crest of the ilium, the right from the lower border of the same rib, being some one-half an inch lower than the left. They about correspond to the twelfth dorsal and first and third lumbar vertebræ, and diverge somewhat as they descend. Each is embedded in a mass of fat behind the peritoneum, which touches them only slightly

in front. Perched on the upper, inner part are the two supra-renal capsules. The kidney is about four inches long, two broad and one thick. It is peculiar in outline, hence the name reniform. The anterior surface is convex, the posterior, slightly flattened; the upper end is the larger; the outer border is convex, the inner, concave and presents a deep depression, called the hilum of the kidney, through which the duct and blood vessels pass, in the following order: the renal vein in front, the duct, or ureter, behind and the renal artery between the two. The hilum leads to a cavity in the organ, called the sinus. The kidney weighs four or five ounces.

Structure.

The kidney is invested by a fibrous coat, which can be easily stripped off, thus exposing the proper tissue, to study which the kidney should be split longitudinally, beginning at its external border and passing through its width. It is then seen to consist of two portions, an outer layer, red in color, which forms about three quarters of the organ, and within this is a portion of a lighter red forming the remaining fourth. The outer is called the cortical, the inner the medullary portion. The inner portion is made up of conical masses called pyramids of Malpighi; they are arranged with their bases toward the cortical portion and their apices toward the hilum and are from eight to eighteen in number. Each pyramid consists of hundreds of straight tubules, leading from the cortical portion, where the urine is secreted, to the apex or papilla of the pyramid, where they discharge the urine. These pyramids are separated by prolongations of the cortical substance, which projects between them.

The urine, which drops from the papilla, is carried off by coalescing ducts having different names, all of which finally terminate in one duct called the ureter, which in turn opens into the urinary bladder. The course can best be understood by following it from below up. Beginning with the ureter we find that, just before it reaches the kidney, it begins to enlarge forming what is called the pelvis of the ureter, which entering at the hilum, occupies the sinus of the kidney. The pelvis of the ureter soon divides into three tubes called infundibula, one infundibulum collecting the urine from each third of the organ. Each infundibulum, after a short course, subdivides into a number of short tubes called calices, each calyx terminating by surrounding the apex of one or more pyramids. The course of the urine, then, after secretion in the cortical portion is (1st) through the uriniferous tubules, which form the pyramids of Malpighi (2d), dropping from the apex or papilla it falls into (3d) the calyx, which uniting with other calices from its third of the organ, forms (4th) an infundibulum, which combines with the other two infundibula to form

(5th) the pelvis of the ureter, which (6th) contracts to the ureter proper which, lastly, opens into (7th) the bladder.

The Ureter.

The ureter commences at the kidney in a dilated portion called the pelvis, and, contracting to a small tube—about the size of a crow's quill—passes down beside the vertebral column to the brim of the pelvis, descends in the pelvis behind the bladder, and approaching its fellow, opens into the back part of the base of the bladder. The apertures for the two ureters are about two inches apart, and the tubes pierce the coats of the bladder in an oblique direction. The length of the ureter is from sixteen to eighteen inches.

The ureter—lying behind the peritoneum—consists of three coats, an external fibrous coat, an internal mucous, and, between these, an external longitudinal and an internal circular muscular coat. This description applies to pelvis, infundibulum and calyx. Near the bladder there is another layer of longitudinal muscular fibres lying between the circular fibres and the mucous membrane.

The Urinary Bladder.

The bladder is the reservoir for the urine. It is a membranous sac which lies in the pelvis, just in front of the rectum, in the male, and of the uterus and vagina in the female. Its shape, when distended, is ovoidal, or pyriform, the large end being below. When empty, it is flattened against the pubes and is somewhat triangular. The direction of its long axis is downward and backward. The capacity of the bladder is very variable, though, in health, the urine is voided when half pint to one pint has been secreted. The upper third of the organ, about, is called the superior fundus, summit or apex; its middle third the body; the lower third the base, or fundus. The channel through which the urine leaves the bladder is called the urethra, whose aperture is seen in the lower front portion. This part of the bladder is called the neck, and lies embedded in the prostate gland. In structure the bladder consists of the following coats: 1st. The internal is mucous membrane. At the neck of the bladder there is a slight prominence, generally absent, called the uvula vesicæ, seen just at the commencement of the urethra. Between the uvula vesicæ in front, as its apex, and the openings for the ureters, as its posterior angles, there is a triangular space called the trigonum vesicæ, or triangle of the bladder, whose base is formed by a line drawn between the openings for the ure-

ters, and whose sides are formed by a line on either side running from this point to the uvula and represented by a ridge in the mucous membrane made by a bundle of longitudinal fibres from the ureter. This space is by far the most sensitive part of the bladder, and corresponds to a similar space on the exterior of the base. 2d. The muscular coat is held to the mucous membrane by a layer of areolar tissue. It consists of longitudinal and circular fibres, the longitudinal forming two layers between which are found the circular. The circular fibres, at the neck of the bladder, are aggregated into a considerable mass, which by their tonic contraction, keep closed the opening of the urethra. 3d. The external coat is serous and incomplete. In the male it covers the summit, sides, posterior aspect and posterior part of the base of the bladder, leaving uncovered the front and the front part of the base.

The Urethra in the Male.

The urethra is the last division of the canal which the urine traverses in seeking an outlet from the body. It commences at the neck of the bladder and terminates at the meatus urinarius, its opening on the free extremity of the penis. Its length is variously estimated, owing to the varying length of the penis which it tunnels. It is divided into three portions, the prostatic, which begins at the neck of the bladder and pierces the prostate gland to appear at its apex and become the second, or membranous portion, which passes on to enter the bulb of the corpus spongiosum and become the third, or spongy portion. The spongy portion continues through the corpus spongiosum to terminate at the meatus urinarius. It is the longest portion and the most variable in length. The length of the urethra as a whole is usually given as seven and a half inches of which the prostatic portion occupies about one and one-fourth inches, the membranous three-fourths of an inch and the spongy portion the remainder. The prostatic portion is the largest.

The Prostate Gland.

This gland is a small horse chestnut-shaped body, found in the male, with its base against the neck of the bladder and its apex projecting forward. Its length is about one and one-fourth inches, its breadth, one and one-third, and its depth about one-half inch. It is invested in cellular tissue and has a proper fibrous capsule; and it consists of interlacing unstriated muscular fibres, in the interstices of which are found the follicles of the gland, which secretes a milky fluid. It is divided into three lobes, two lateral and an inferior, or isthmus. Passing through it, nearer

its upper than its lower surface, is the prostatic portion of the urethra. On the floor of this portion of the urethra is seen a prominence of the mucous membrane, about one-half an inch long, called the veru montanum. On either side of this prominence is a depression in the floor of the urethra, called the sinus prostaticus, in which are found some ten to fifteen minute apertures—the openings of the prostatic follicles; while in front of the veru montanum is a small saccular cavity, projecting backward, called the sinus pocularis, or utriculus prostaticus, or uterus masculinus. Opening on either side of the orifice of this sinus is seen a small aperture, the opening of the ejaculatory ducts, which pass back, one on either side, to two lobulated oblong bodies, one on either side, just behind the prostate gland, called seminal vesicles.

Seminal Vesicles.

Each seminal vesicle is a reservoir for the seminal fluid, and is formed of a tube, about the size of a goose quill, five or six inches long, coiled into an oblong mass, which lies on the lower surface of the base of the bladder, its large end projecting backward and outward from its fellow, the small end being in front just behind the prostate gland and approaching its fellow. The posterior extremities are about two inches apart, and a line drawn from one to the other is the base of a triangular space, whose apex is at the prostate gland, which may be designated as the intervesicular triangle. This space is devoid of peritoneum. The point where the peritoneum strikes the base of the bladder corresponds to the posterior boundary of this triangle, whose sides are formed by the seminal vesicles with the vas deferens of either side lying internal to them.

Vas Deferens.

Commencing at the upper extremity of the testicle the vas deferens forms one element of the spermatic cord, the others being blood vessels, nerves, &c., which ascends to the upper border of the pubes, where it plunges into the anterior abdominal wall, through the external abdominal ring, then outward, along the inguinal canal to the internal abdominal ring, where it turns backward through that ring to enter the abdominal cavity. As soon as the cord enters the abdomen its various constituents disperse. The vas deferens passes to the upper part of the side of the bladder, thence down its posterior surface, along the inner edge of the seminal vesicles, at the anterior extremity of which it is joined by the tube, whose convolutions form the seminal vesicles, and the two form the ejaculatory duct.

The Ejaculatory Duct.

The two ejaculatory ducts lie very near each other and pass forward and upward, through the substance of the prostate gland, for about three-quarters of an inch, to open on the sides of the aperture of the sinus pocularis, which is found at the base of the veru montanum, in the floor of the prostatic portion of the urethra.

The Penis.

The penis consists of three cylinders, two, lying side by side called the corpora cavernosa, and one in a groove between these known as the corpus spongiosum. When dissected out the corpora cavernosa are seen to commence by attachment to bone—the ischio-pubic rami—by a portion called the crus which terminates posteriorly in a pointed extremity; while anteriorly it increases in size to become the corpus cavernosum. The corpora cavernosa do not extend to the extremity of the penis, but stop a little behind the meatus urinarius. The corpus spongiosum begins by a dilated portion called the bulb, situated between the crura, into which the membranous portion of the urethra passes to become the spongy portion. It then passes forward, tunnelled by the urethra, lying between the corpora cavernosa, until it reaches their anterior extremity, when it suddenly dilates into a considerable mass, which covers the extremity of the corpora cavernosa, and projects in a ridge beyond them. This dilated extremity is called the glans penis or head. The glans has its base backward, terminating in a rounded edge, raised above the surface of the corpora cavernosa, which is called the corona glandis, while the constricted portion behind it is called the neck. From the corona the glans slopes to its termination around the meatus urinarius. That portion of the penis extending from the crura, or rather where the three cylinders come in close relation, forward to the head, is called the body of the organ; and the two crura and the bulb constitute the root of the penis.

Surrounding, and loosely adherent to, the body is a thin skin, which in front is formed into a fold, movable over the glans called the prepuce. On the lower aspect of the glans the prepuce is attached by a process, extending forward to the meatus urinarius. This attached portion is called the frænum.

Passing through the corpus spongiosum from the bulb behind to the meatus urinarius in front, is the spongy portion of the urethra, which, just before its termination at the meatus, presents a considerable dila-

tion, called the fossa navicularis. The mucous membrane lining the urethra presents many follicles, called lacunæ, opening into the canal. When the mucous membrane reaches the meatus it is continued over the glans penis and the deep surface of the prepuce.

The tissue of the three cylinders is that known as erectile tissue. Each cylinder is enveloped by a strong fibrous sheath, that of the corpus spongiosum being more delicate than the others. Within this sheath the structure consists of interlacing bands of fibrous tissue, the interspaces between which contain dilated blood vessels, which when turgid with blood, produce erection. The two corpora cavernosa, at the posterior part of the body of the organ, are separated some little distance from each other, but as they pass forward, come much closer together, for the fibrous tissue between them is thick posteriorly, whereas in front it is thin and presents numerous slit-like interruptions which have obtained for it the name of septum pecteneiform.

The Testicles—Testes.

The testicles are a pair of small organs whose function it is to secrete the semen. They are found suspended by the spermatic cord, in the bag called the scrotum, separated from each other, although lying side by side. Each testicle weighs from three-fourths to one ounce or more; it is an inch to an inch and a half long, about an inch antero-posteriorly and half an inch transversely. It occupies the back of the scrotum, its position being from above downward and backward.

The scrotum is thus constituted: 1st, an external covering of skin; 2d, beneath this a musculo-fibrous covering called the dartos; 3d, lining the interior of the dartos, and also enveloping the testicle, a serous membrane called the tunica vaginalis. That portion of the tunica vaginalis lining the dartos is called the parietal, and that lining the testicle the visceral layer.

There are two cavities in the scrotum separated by a septum from the dartos called septum scroti. There is a tunica vaginalis for each testicle.

Structure of the Testicle.

When the visceral layer of the tunica vaginalis is removed we find beneath a bluish white fibrous investment of the testicle called the tunica albuginea. This is much thickened at the back part, where it is called the mediastinum.

Lining the inner aspect of the tunica albuginea is a reddish vascular investment called the tunica vasculosa. Lying on the posterior aspect

of the testis is a flattened body called the epididymis, which is made up of the convolutions of the tube conveying away the semen. The upper portion of the epididymis is alone permanently connected with the testicle, for it is here that the ducts, which transmit the semen from the testes, emerge and unite to form the epididymis. The upper portion of the epididymis is called the globus major, the lower portion, which terminates in the vas deferens, the globus minor. The intermediate portion is called the body. The semen is secreted in what are called the lobules of the testicles, which number from 250 to 400, each lobule being separated from those adjacent by septa sent in from the tunica albuginea, which septa, however, are covered on both sides by a layer from the tunica vasculosa.

Each lobule consists of the convolutions of a small tube some one-two hundreth of an inch in diameter, arranged from before backward with the large end of the convoluted mass in front and the small end behind at the mediastinum, where many lobules unite to form a single duct, which, from its comparatively straight course, is called the rectum. In the testis there are from twenty to twenty-five vasa recta, which plunge into the mediastinum and there unite to form from two to twelve ducts, which ascending through the mediastinum in a sinuous course, are called collectively the rete testis. When the ducts reach the upper extremity of the mediastinum, they terminate in from nine to thirty other ducts, called vassa-efferentia, each of which is thrown into convolutions assuming a conical appearance which are known as coni vasculosi and form the globus major. The bases of the cones terminate in large ducts which unite in the body of the epididymis into one duct whose convolutions, some twenty feet long, form the body and globus minor of the epididymis and then become the vas deferens.

The continuous course of the semen is then, lobule, which may be composed of as many as three tubes, vasa recta, rete testes, vasa efferentia, coni vasculosi, epididymis, body and globus minor, vas deferens.

The Ærial Apparatus.

The air reaches the lungs from the throat through a tube which has received different names in its various parts. It is first called the larynx, then the trachea, which, opposite the fifth dorsal vertebra, divides into the two bronchi.

The Larynx.

The larynx is formed upon a framework of separate cartilages which require to be studied under individual names.

Thyroid Cartilage.

The thyroid is the upper, the front and the largest cartilage of the larynx. In front it comes to an acute angle and produces the prominence, called the Adam's apple, pomum Adami. From this acute, or receding angle, it passes backward and outward on either side in a quadrilateral plate called the ala of the thyroid cartilage. On the outer surface of the ala is an oblique ridge, running from above downward and forward, terminating at each end in a prominence, or tubercle. The posterior border is rounded and free and prolonged both above and below into processes called the superior and inferior cornua, each terminated by a tubercle. The superior cornu is the longest. The upper border is sinuous. Commencing in the notch at the receding angle it passes backward to become continuous with the superior cornu. The inferior border is also sinuous and continuous with the inferior cornu.

Cricoid Cartilage.

The cricoid cartilage is a ring and lies supporting the thyroid, between whose inferior cornua it is grasped. It is narrow in front—not more than one-fourth of an inch deep—but a full inch in depth behind. Its upper border slopes upward and backward, presenting in the centre, behind, a slight notch, and, on either side of this an articular facet, on which is perched another cartilage the arytenoid. Running down the middle line behind is a ridge, on either side of this a slight depression, and, further forward, on the side of the cartilage, a rounded, articular facet, for the inferior cornu of the thyroid cartilage.

Arytenoid Cartilages.

The arytenoid cartilages are found upon the cricoid, occupying the articular facets on its upper border. The cartilage is triangular in shape, its base below and its apex above; its posterior surface concave, its anterior equally convex; its inner face, which looks towards its fellow, narrow and flat. The apex is surmounted by another small cartilage called cornicula laryngis. The two arytenoid cartilages occupy the interval between the alæ of the thyroid cartilage.

Epiglottis.

The epiglottis lies just above the receding angle of the thyroid cartilage. It is leaf shaped, its apex downward and forward and its base,

which presents a slight notch, upward and backward and lying at the base of the tongue. Its upper end may be sometimes seen by looking down the throat.

These several cartilages are held together and to the hyoid bone by the following ligaments. The hyoid bone lies just above the superior border of the thyroid cartilage and passing between them is an unbroken membrane called the thyro-hyoidean, and in each of the posterior edges of this membrane a rounded cord, which passes from the superior cornu of the thyroid cartilage to the posterior extremity of the hyoid bone, called the thyro-hyoid ligament.

The thyroid and cricoid cartilages are held together by the following ligaments. The extremity of each inferior cornu of the thyroid cartilage is held to the facet on the side of the cricoid by a capsular ligament. The considerable interval which exists in front between the lower border of the thyroid and upper border of the cricoid is closed in by a fan-shaped yellow elastic membrane, called the crico-thyroid membrane, which is attached below to the upper border to the cricoid and above to the lower border of the thyroid for about one-fourth of an inch on each side of the middle line and then presents a free edge, covered by mucous membrane, which posteriorly is attached to the anterior angle of the base of the arytenoid cartilage, forming the lower, or true vocal chords.

Passing now to the epiglottis, we find its apex held to the receding angle of the thyroid by a narrow ligament called thyro-epiglottic. It is connected to the hyoid bone by a ligament called hyo-epiglottic, which is attached to the epiglottis on its front edge near its apex. The back of the tongue and the epiglottis are connected by three ligaments, one in the centre and one on each side, called glosso-epiglottic, middle and lateral. Lastly we have the ligaments attached to the arytenoid cartilages, the base of each being held to the cricoid by a capsular ligament, the posterior part of which is thickened and called crico-arytenoid. Besides these the arytenoid cartilage is connected to the receding angle of the thyroid by means of two long ligaments. They are attached behind to the base of the arytenoid, one above the other, and in front to the receding angle of the thyroid. The lower one is called the inferior thyro-arytenoid ligament and it and its fellow constitute the true vocal chords, these being the upper edge of the crico-thyroid membrane.

The larynx is lined by mucous membrane continuous with that of the mouth. Looking into the cavity of the larynx from below, at a certain point, the cavity is suddenly narrowed by two ridges, one on either side, running from before, where they are close together, backward, diverging

as they go and leaving a triangular interval between them called the chink of the glottis, or rima glottidis; these ridges are produced by the inferior-thyro arytenoid ligaments, or true vocal chords. Reversing the larynx and looking into its cavity from above, the opening into it from the pharynx is seen to be limited by the epiglottis, which projects upward and backward. Over the opening, posteriorly, are seen the arytenoid cartilages; laterally are folds of mucous membrane, the ventricular bands; the opening is heart shaped with its broad end in front. Down in the cavity are seen the ridges on each side, one above the other. The lower pair are those seen from below; the upper correspond to the superior thyro-arytenoid ligaments and are the false vocal chords. As they are much less prominent than the true chords, they cannot be seen when the cavity is viewed from below. The space between the false vocal chords bears no name, but the similar and smaller space between the true chords is known as the rima glottidis. On each side of the glottis is another space formed by the recession of the walls of the larynx, between the true and the false vocal chords, which is called the ventricle of the larynx, and this space is continued up on the outside of the false vocal chords, between it and the wall of the larynx, some distance. This prolongation of the cavity is known as the sacculus laryngis. To get a definite idea of the ventricle and larynx, consider them as having the following boundaries: the ventricle is bounded on the outer side by the wall of the larynx, ala of the thyroid cartilage; on the inner side is the space called the glottis; above are the false vocal chords and the sacculus laryngis; below, the true vocal chords. The glottis is bounded above by the nameless interval between the false vocal chords; below, by the rima glottidis; on each side, by the ventricle, for it lies between the two ventricles which extend from the wall of the larynx inward only as far as a line drawn from the inner edge of the false to the inner edge of the true vocal chords.

Trachea.

Succeeding the larynx comes the second subdivision of the air tube known as the trachea. Commencing where the larynx terminates, opposite the fifth cervical vertebra, it descends in front of the vertebral column, from which it is separated by the œsophagus, and terminates by dividing, opposite the fifth dorsal vertebra, into the right and left bronchi. It is a cylindrical tube, flattened on its posterior aspect, about four and a half inches long and one inch in diameter. In the female these dimensions are somewhat less. Its appearance, when viewed from the front, is annulose, due to the fact that its largest element is a number—fifteen to twenty—of cartilaginous rings, one lying above the other.

The flattening posteriorly is due to the fact that each ring is wanting in its posterior third, thus leaving this portion of the tracheal wall wanting in cartilage. The rings are not in contact but are separated, and at the same time maintained in position by a fibro-elastic membrane, which covers both surfaces of the rings, for they, in fact, lie embedded in the substance of the membrane. Between the posterior extremities of the rings, over the interval left by their imperfection, the membrane is continued and is here strengthened by unstriated muscular fibres, both longitudinal and transverse. The longitudinal are unimportant; but the transverse, passing between the posterior extremities of the rings, can, by their contraction, diminish the diameter of the trachea.

The interior of the trachea is lined by mucous membrane, continuous with that of the larynx above and prolonged below into the bronchi, bronchial tubes and ultimate air cells of the lungs. Beneath the mucous membrane, between it and the fibro-elastic membrane, is a yellow elastic membrane which is much more distinct posteriorly, where the fibres which compose it are gathered into longitudinal bundles. To sum up its structure we say the trachea is lined by mucous membrane, beneath this yellow elastic fibres, external to this a yellow fibro-elastic membrane lying in which are the rings of the trachea. Besides these there are transverse muscular fibres between the posterior extremities of the rings, and, scattered around the tube some unimportant longitudinal fibres.

Thyroid Gland.

Lying in relation with the upper part of the trachea and the larynx is a ductless gland called the thyroid. It consists of two similar lobes, each about two inches long and three-fourths of an inch in diameter, conical in shape with its base below and apex above. These two lobes lie one on each side of the upper part of the trachea, and are usually connected by a third lobe, or isthmus, which is a narrow strip passing across the front of the second and third rings of the trachea to the base of the other lobe, the apex of each lobe passing up beside the larynx. The color is a brownish red. The weight is about one and one half ounces. In the female it increases in size at each menstrual period.

In structure the gland consists of numerous lobules, which are made up of many vesicles, containing a peculiar fluid, cells and nuclei, besides which is a network of blood vessels, for the gland is extremely vascular, each lobe receiving two large arteries, one from above and the other from below. Its constituents are held together by areolar tissue, which separates its lobules.

Bronchi.

Taking up the air tube again, we find that the trachea, or wind pipe, when it has reached a point corresponding to the front of the fifth dorsal vertebra, forks, the prongs of the fork being known as the bronchi, right and left. Each bronchus extends from its origin to the inner surface of the lung, forming one element of the root of the lung. The two bronchi are not similar and the difference between them may be thus stated: The right is shorter, larger and more nearly horizontal, coming off nearly at right angles to the trachea, whereas the left has a considerable obliquity downward. If the trachea be cut across near its termination and the cavity examined, a slight antero-posterior ridge is found separating the two bronchi. This ridge lies nearer the left than the right side and in consequence a foreign body falling into the trachea is more likely to enter the right than the left bronchus. The left bronchus is about two inches long, the right about an inch. In structure they exactly resemble the trachea.

Lungs.

The lungs are a pair of organs found in the thoracic cavity, one on each side of the middle line, resting upon the diaphragm below and having the heart enclosed in the pericardium, lying between them. Each lung is conical in shape with its base below, resting on the upper surface of the diaphragm and concave in shape to correspond with that surface. The apex is above and extends about one and one-half inches into the root of the neck. Besides the base and apex, each lung presents the following subdivisions: the posterior border, long, thick and rounded, contrasting strongly with the anterior, which is thin, short and sharp. The outer surface is convex to correspond with the concave inner face of the chest wall. The inner face, which looks towards its fellow, is marked by a concavity which is caused by the heart, in the pericardium, which lies between the two lungs. The inner surface of the left lung is much more concave than that of the right, owing to the inclination of the heart to the left. A little above and posterior to the centre of each lung on its inner face the root is seen to enter its substance. The root is made up of various elements, nerves, lymphatics, &c., but its chief constituents are the bronchus, pulmonary artery and two pulmonary veins. From behind forward, the relation these structures bear to one another is the same for both lungs, viz: Bronchus, artery, vein: but from above downward the relation is different in the two lungs. In the right it is bronchus, artery, vein: in the left, artery, bronchus, veins. The veins, on both

sides, are the lowest, and the difference is caused by a change in the relation of the artery and bronchus in the left lung, which is accounted for by the downward inclination and greater length of the left bronchus.

Each lung is divided by fissures into lobes, the right into three and the left into two. Commencing about three inches from the apex, on the posterior border of each lung, an oblique fissure passes through the lung downward and forward to near the lower extremity of the anterior border. In the right lung there is another fissure which begins near the centre of the oblique fissure and runs nearly horizontally forward to the anterior border, thus dividing the right lung into three lobes known as upper, middle and lower. In the left lung there are but two lobes, upper and lower. The right lung is slightly larger than the left, owing to the encroachment of the heart on the left lung. The right, however, is shortened by the right lobe of the liver, which bulges the diaphragm on that side, and the difference is in reality not great—the right lung weighing about twenty-two and the left twenty ounces.

The Pleuræ.

Enveloping each lung and lining the chest wall is a serous membrane, one on each side. These two membranes are the two pleuræ. They are separate from each other and each forms a distinct closed sac for its lung, one face of the sac lining the inner surface of the chest wall while the other completely invests the lung. In front, behind the sternum, the two pleuræ approach each other closely, and are sometimes in contact about the centre of the sternum.

In tracing the reflections of the pleura, as it is a closed sac, we can begin at any point and following it around will return to that point. Beginning on the root of the lung we trace first the visceral layer, or pleura pulmonalis, and then the parietal layer, or pleura costalis, the two being continuous. From the front of the root, the pleura passes forward on the inner face to the anterior border of the lung, then around the convex outer surface to the posterior border and then forward on the inner face to the back of the root of the lung and then to the side of the vertebral column, where it becomes the parietal layer, which passes thence along the inner surface of the chest wall to the sternum in front, where it leaves the chest wall and passes backward on the pericardium to the front of the root of the lung to become continuous with the visceral layer which we have just traced. The free surfaces of the two layers secrete a small amount of liquid which renders the movements of the lungs in respiration easy.

Structure.

Each lung has an external serous coat, the pleura, beneath which is an areolar elastic coat, which sends processes into the substance of the lung to separate it into numerous subdivisions, called lobules, where the function of the lung, the æration of the blood, is effected. As soon as the bronchus reaches the lung it forks into bronchial tubes and these ramify throughout the lung continuously subdividing, generally by forking, until they finally open into the air cells which form the lobules, there being several thousands of these cells in each lobule, say, 20,000, every lobule having one bronchial tube. On the walls of these cells the blood vessels ramify. These walls separate adjacent cells, which open into a common cavity, called an intercellular space, with which the bronchial tube communicates. The bronchial tubes differ in structure from the bronchus. At first the only difference is that the cartilages cease to be ring shaped and become flat and scale like and scattered all around the tube; but toward the termination of the tube the cartilages disappear entirely and the tube consists altogether of fibrous tissue, in which are many elastic fibres, muscular fibres and mucous membrane. The diameter of the smallest tubes is from one-fiftieth to one-thirtieth inch, and of the air cells from the one-two hundredths to the one-seventieth of an inch.

Before birth the lungs are almost colorless, but, as soon as the blood reaches the wall of the air cells, the lung assumes a pink color, which, during life, gradually fades to a slate color; and this, in the decline of life, may change to an almost black hue, especially in men and in the posterior part of the lung, owing to the deposition of minute particles of carbon.

The Mediastinum.

Between the opposing surfaces of the pleuræ and the sternum in front and vertebral column behind, there is a space, called the mediastinum, which is divided into the superior mediastinum, all that part above the level of the pericardium, and the inferior mediastinum which is further subdivided into three portions, anterior, posterior and middle.

The superior mediastinum is bounded below by a plane extending from the junction of the gladiolus and manubrium sterni to the lower part of the body of the fourth dorsal vertebra.

The anterior mediastinum is bounded in front by the sternum and lower costal cartilages of the true ribs, behind by the pericardium and on either side by the pleura. It is oblique in direction, from above downward and to the left and is larger below than above.

The middle mediastinum is the broadest part of the inter pleural space and contains the heart and pericardium.

The posterior mediastinum is irregularly triangular, being bounded in front by the pericardium and roots of the lungs, behind by the vertebral column and laterally by the pleuræ. It extends from the fourth dorsal vertebra downward and contains many important cords.

The Heart.

The heart is a hollow muscular organ found in the cavity of the chest, lying between and almost surrounded by the two lungs; it rests upon the convex upper surface of the diaphragm and is contained in the middle mediastinum. It is contained in a closed cavity, formed by the pericardium, lying, for the greater part of its extent, unattached; but, since its function is the maintenance of the circulation of the blood, the vessels which bring this to, or carry it from the heart all communicate with its upper part or base, and thus maintain it in position. To render its movements free in the pericardium, that structure is lined by a serous membrane which, like all others, is a closed sac, one layer lining the pericardium and the other covering the heart from the origin of the vessels on one side to the same point on the opposite side. The portion lining the pericardium is called the serous pericardium and the membrane which it lines the fibrous pericardium. The heart is conical in shape, its base being above and to the right and its apex below and to the left. It is about five inches long, three and a half inches transversely and two and a half antero posteriorly. Its weight is from nine to twelve ounces, varying in the two sexes and being slightly larger in the male.

The exact position of the heart is thus stated: the base lies behind the sternum, corresponding to a line drawn between the upper borders of the extremities of the third costal cartilages; the apex is downward and to the left, striking the chest wall at the space between the fifth and sixth ribs, three to three and one-half inches to the left of the middle line, about opposite the gladio-xiphoid joint.

The cavity of the heart is separated into a venous and an arterial half, or apartment, by an obliquely vertical septum, which cuts off all communication between the halves. The position of this septum can be predicted by an inspection of the exterior of the heart, for it is marked by a groove passing from the base anteriorly and to the left downward to the right of the apex to run along the posterior aspect of the heart and terminate at the base, towards its right aspect. An artery is found lying in this groove, which is called, for a reason hereafter given, interventricular. From the position of the groove it is seen that the apex of the

heart is formed entirely by the left half, the front of the heart mainly by the right half, while the back is the product, principally, of the left half.

When the heart is laid open its entire cavity is seen to be lined by a serous membrane, continued into the vessels which communicate with it, called the endocardium, and that each lateral half is subdivided by a partial horizontal septum into two cavities, the upper called the auricle, right or venous, and left, or arterial, the lower, the ventricle, right, or venous and left, or arterial.

The position of the horizontal septum is indicated by a groove passing around the heart called auriculo-ventricular.

In the adult the venous blood of the entire body, with the exception of that of the heart itself, is returned into the venous auricle by two great veins called venæ cavæ, superior and inferior, the one bringing the blood from the head and upper extremities, the other from the lower extremities and body. The venous blood from the heart is returned to the venous auricle by a separate vein called the coronary, which, just as it is about to enter the auricle, dilates into what is known as the coronary sinus. Besides these channels for the return of the venous blood, there exist numerous minute apertures in every cavity of the heart through which its venous blood may enter to a small extent. These are called foramina Thebesii. The venous blood thus collected by the venous auricle is driven by its pulsation into the venous ventricle, with which it communicates by an aperture through the horizontal septum called the venous auriculo-ventricular opening. From the venous ventricle the blood is sent into the pulmonary artery which soon divides into a branch to each lung.

Taking up the appearances seen in the cavities of the heart, we begin with the venous auricle.

The venous auricle consists of two portions; the larger part is called the sinus, but, communicating with this and projecting forward, is an ear-shaped addition, called the appendix auriculæ—hence the name of the auricles. The sinus of the venous auricle presents the following objects: At its upper back part, the opening of the superior vena cava; at the lower back part, the opening of the inferior vena cava; between the two openings a slight thickening of the auricular wall called the tubercle of Lower; betweeen the opening for the inferior vena cava and the auriculo-ventricular opening is the opening for the coronary sinus, guarded by a valve-like fold of endocardium called the coronary valve; on the septum between the two auricles, an oval depression, called the fossa ovalis, and surrounding this, except below, a ridge called annulus ovalis; extending

along the wall of the auricle from the opening of the inferior vena cava to the fossa ovalis, is a ridge, the remains of the Eustachian valve of the fœtus; the lining membrane presents ridges caused by little muscular columns called musculi pectinati; the opening through the horizontal septum into the venous ventricle, and, lastly, foramina Thebesii.

To sum up we have the following openings: 1st, superior vena cava; 2d, inferior vena cava; 3d, coronary sinus; 4th, foramina Thebesii; 5th, venous auriculo-ventricular; and six other appearances, viz: 1st, musculi pectinati; 2d, tubercle of Lower; 3d, coronary valve; 4th, Eustachian valve; 5th, fossa ovalis; 6th, annulus ovalis.

The venous ventricle has two openings communicating with it, one for the pulmonary artery and the other from the venous auricle. The venous auriculo-ventricular opening is surrounded by an oval, fibrous ring to which the segments of the valve are attached. To prevent regurgitation of blood when the ventricle contracts, the opening is guarded by a valve consisting of three flaps, formed of folds of endocardium strengthened by fibrous tissue and some muscular fibres, which are triangular in shape with the base attached to the fibrous ring and the apex free. When the ventricle contracts the blood insinuates itself behind these flaps, which when the ventricle is passive, hang loosely in its cavity, and forces them before it until they come together, their apices meeting in the centre of the opening. The segments, which are quite flexible, are kept from being forced into the auricle by the attachment of a number of muscular and tendinous cords which hold them in the ventricle. The muscular columns are called columnæ carneæ and are divided into three sets arranged as follows: some form mere ridges, being attached to the wall of the ventricle throughout their length; the second set are attached to the wall of the ventricle by each end and are free in the middle; while the third are attached by one end only to the ventricular wall, terminating at the other in tendinous cords which are themselves attached to the ventricular aspect of the segments of the valve and are only long enough to allow these to close without floating into the auricle. The valve thus formed is known as the tricuspid, and the tendinous cords as chordæ tendineæ.

The blood, driven by the contraction of the venous ventricle, is forced into the pulmonary artery and, when the ventricle ceases to contract, would again return to it were it not for a valvular arrangement here, called the pulmonary semilunar valve, which guards the orifice of the pulmonary artery. The semilunar valve is three segments arranged around the interior of the pulmonary artery, just at its commencement. Each segment is semilunar in shape, its convex border being attached while the superior border is free and straight. They consist of folds of

lining membrane, strengthened by fibrous tissue which, just at the centre of the free edge, is aggregated into a projection called corpus-arantii. In the centre the valve lacks fibrous tissue and presents a lunated space. Behind each segment there is a depression caused by a dilatation of the artery, called sinus of Valsalva, and when the ventricle ceases to contract the blood, seeking to re-enter the cavity, enters the sinuses of Valsalva and forces the segments together until they meet along their free edges and close the orifice. The corpora arantii have small effect in closing this orifice.

The objects seen in the right ventricle then are: 1st, columnæ carneæ; 2d, chordæ tendineæ; 3d, venous auriculo-ventricular opening; 4th, opening into pulmonary artery; 5th, tricuspid valve; 6th, semilunar valve; 7th, foramina Thebesii.

The arterial auricle has thicker walls than the venous, being about one-eighth inch thick while the right is only one-twelfth inch. It presents musculi pectinati, which are fewer in number than in the right auricle, being almost confined to the appendix auriculæ; the arterial auriculo-ventricular opening; the openings for the four pulmonary veins, which return the blood from the lungs. Two of these veins come from each lung, the two from the left sometimes uniting before entering the auricle.

To sum up, we have 1st openings for four pulmonary veins, 2d arterial auriculo-ventricular opening, 3d musculi pectinati.

The arterial ventricle has walls three times as thick as those of the venous, being seven lines thick while the venous is only about two and a half lines. The left side of the heart, therefore, is much more powerful than the right; this being due to the fact that while the venous ventricle has only to drive the blood into the lungs, the arterial has to send it throughout the entire system. On the walls of the arterial ventricle are seen columnæ carneæ, much more prominent and more intimately intersecting than in the venous ventricle, but similar to them in arrangement, viz: some attached throughout their length, some at each end and free in the middle, some attached at one end to the wall of the ventricle, while the others terminate in tendinous cords attached to the ventricular aspect of the bicuspid valve. The blood is forced from the arterial auricle into the arterial ventricle, and when this contracts it is forced into the aorta. Both these openings are guarded by valves. The valve guarding the arterial auriculo-ventricular opening is known as the bicuspid, or mitral, and is arranged upon the same principle as the tricuspid, being made up of two segments attached by their bases to the fibrous ring around the opening while their apices are free in the cavity of the ventricle. It consists of folds of endocardium strengthened by fibrous and muscular tissue

and receives the attachment of the chordæ tendineæ. It differs from the tricuspid valve in being stronger and in having only two segments. The opening into the aorta is guarded by the aortic semilunar valve, which is in every way the counterpart of the pulmonary semilunar, except in being larger and stronger, consist of three segments of lining membrane and fibrous tissue, with corpora arantii, lunated spaces and sinuses of Valsalva. The mechanism of their action is also the same as in the pulmonary semilunar.

To sum up, there are in the arterial ventricle: 1st, columnæ carneæ; 2d, chordæ tendineæ; 3d, arterial auriculo-ventricular opening; 4th, aortic opening; 5th, bicuspid valve; 6th aortic semilunar valve.

The Brain.

The chain of nervous centres, known as the cerebro-spinal axis, is divided into two portions, one contained in the spinal canal, called the spinal cord, or medulla spinalis, the other contained in the cranium and called the brain, or encephalon, the latter name including the membranes.

Enveloping each of these portions, and lining its containing cavity, are three membranes, lying one within the other, called the investing membranes, or meninges.

The Membranes of the Brain.

The three investing membranes of the brain are: 1st, dura mater, lying next the cranial wall; 2d, pia mater, lying next the brain; 3d, arachnoid, between these two.

The dura mater is a grayish white, strong fibrous membrane which lines the inner surface of the cranial wall adhering pretty close to the bone, particularly at the base of the cranium and in the course of the sutures. Its inner surface is smooth and glistening because lined by the arachnoid. Besides lining the interior of the cranium, the dura mater gives off processes which insinuate themselves between certain portions of the brain. These processes, or partitions, are three in number, as follows: 1st, the falx major, or falx cerebri, is a sickle-shaped falciform process of the dura mater which lies in the longitudinal fissure, attached in front to the crista galli and extending along the middle line to the anterior occipital protuberance behind, being continuous with the dura mater along the vault of the cranium between these points and separating the two hemispheres of the cerebrum.

For a certain distance forward from the anterior occipital protuberance, corresponding in extent to the cerebellum, its lower edge is adherent to the upper surface of the tentoriun.

2d. The tentoriun cerebelli is stretched horizontally across the inferior occipital fossæ, attached behind to the horizontal limbs of the occipital cross and in front to the upper border of the petrous portion of the temporal bone, on each side, and to the clinoid processes; 3d, the falx minor, cerebelli, is a narrow process which separates the two lobes of the cerebellum; it is attached along the lower vertical limb of the occipital cross and forks as it approaches the foramen magnum, where it ceases.

The arachnoid is a serous membrane and consequently a closed sac, one of its layers lining the inner surface of the dura mater, and called the parietal layer, the other investing the brain, from which it is separated by the pia mater, and called the visceral layer. Though it envelopes the brain it does not dip into the sulci but leaps from convolution to convolution.

The pia mater is an extremely thin membrane, very vascular, consisting, in fact, of interlacing small blood vessels lying on the surface of the brain. It not only covers the convolutions but passes down into the sulci, and the space thus left between the pia mater, as it dips to the bottom of the sulci, and the arachnoid, which passes over the sulci from convolution to convolution, is called the sub-arachnoid space.

The Brain.

The brain is subdivided into four parts, viz: Cerebrum, cerebellum, pons varolii and medulla oblongata.

The cerebrum, seven or eight times the size of the rest of the brain, presents that uneven surface called cônvoluted. It consists of meandering elevations, called convolutions, and corresponding depressions, an inch or so deep, called sulci. When examined closely these convolutions are seen not to be exactly similar on the two sides of the brain.

The cerebrum is subdivided as follows: Upon its upper surface there appears a fissure extending from before backward along the centre, called the longitudinal fissure. This fissure, as may be seen by looking on the base of the brain, extends entirely through, both before and behind; but for the middle third of the cerebrum, it extends downwards only about an inch from the upper surface. The sides of the cerebrum thus separated are called the hemispheres, right and left.

The Base of the Brain.

The base of the brain, that portion which presents to the floor furnished it by the base of the cranium, is composed of portions furnished by the four primary subdivisions and presents many points to be investigated.

Beginning in front we see in the middle line the longitudinal fissure, and on either side of it the first cranial or olfactory nerve, which, emerging from the substance of the brain just at the inner end of the sylvian fissure, extends forward beside the longitudinal fissure, flattened, or somewhat triangular in shape, lying in a groove and terminating near the front of the brain in a dilated portion called the olfactory bulb. Just behind the longitudinal fissure, are seen on the front of the base, two nerves, the second cranial, or optic, which are united behind but diverge from each other forward. The union of the two, situated just between the olfactory nerves and just behind the longitudinal fissure, is called the optic chiasm, or commissure; and, diverging from this chiasm backward are the two flattened cords, called the optic tracts, which, after a short course, disappear in the substance of the brain. In the angular interval left on the side of the optic chiasm, between the optic nerve in front and the optic tract behind, there is a number of small apertures in the substance of the brain, made by tearing out small arteries, which enter here, and this appearance on either side is known as the substantia perforata, or anterior perforated spot. Just behind the optic chiasm, and between the optic tracts, is a grayish prominence called the tuber cinerium; and projecting from the centre of this for about one-sixth inch, a small tube-like prolongation called the infundibulum, which is tipped by a reddish body called the pituitary gland, which weighs five to ten grains, is composed of an anterior and a posterior lobe and lies in the sella Turcica.

Just behind the tuber cinerum are two round, white, pea-like bodies, one on each side the middle line, called the corpora albicantia. Behind these is seen a collection of apertures, just like those forming the two substantiæ perforatæ, called the locus perforatus, or posterior perforated spot. In the centre, just behind this is seen the broad band of transverse fibres called the pons Varolii, and passing forward from this, are two large flattened cords, diverging from each other and intersecting the optic tract of each side before being lost in the brain, known as the crura cerebri. Between the diverging crura postero-laterally, the optic tracts antero-laterally, the optic chiasm in front and the anterior edge of the pons Varolii behind, there is a circumscribed portion of the base of the brain known as the six-sided, or interpeduncular space. Its boundaries are as above stated and it contains the following objects: 1st, tuber cinerium; 2d, infundibulum; 3d, corpora albicantia; 4th, locus perforatus.

The Medulla Oblongata.

Extending from the foramen magnum, or upper border of the atlas, to

the posterior border of the pons Varolii, is found the medulla oblongata, thus establishing connection between the spinal marrow and the brain. It is conical in shape, with the larger end above and forward, and is about one and one-fourth inches in length. Passing down its centre in front is the anterior median fissure, and similarly marking it behind is the posterior median fissure; these, though not entirely bisecting it, serve to indicate its division into lateral symmetrical halves. Each half is subdivided into four portions by three longitudinal grooves. Lying beside the anterior median fissure, and separated by it from its fellow, is the portion called the corpus pyramidale; just behind this, slightly more bulging and separated from it by a fissure, is a second portion called the corpus olivare, being visible for about half an inch only. Behind this a third portion called the corpus restiforme, separated by a groove from the corpus olivare in front and by another slight groove from the fourth portion, the posterior pyramid, which lies behind the corpus restiforme, beside the posterior median fissure by which it is separated from its fellow. The two posterior pyramids are small below, but as they are followed up they suddenly dilate into a bulbous enlargement, and again as suddenly decreasing, separate as they ascend and leave between them an angular interval called the calamus scriptorius—writer's pen. When the medulla oblongata reaches the pons Varolii it seems on superficial view to stop short, but if the surface fibres of the pons, which are transverse in direction, are peeled off, it is seen that the pons, in its centre, consists of vertical, or longitudinal fibres, which are continuous with the fibres of the medulla oblongata below, and, being gathered into two bands, emerge from its anterior border as the two crura cerebri.

SUMMARY.

In summing up the appearances met with on the base of the brain, we find from before backward—1st, longitudinal fissure in the centre; 2d, olfactory nerve and its bulbus olfactorius; 3d, optic nerve; 4th, optic chiasm; 5th, optic tract; 6th, substantia perforata; 7th, tuber cinerium; 8th, infundibulum; 9th, corpus albicans; 10th, locus perforatus; 11th, crus cerebrii; 12th, pons Varolii; 13th, medulla oblongata. Of these thirteen objects, the 2d, 3d, 5th, 6th, 9th and 11th are double, *i. e.*, there is one on each side of the middle line; the others are single and are found on the middle line, extending on each side, more or less.

Structure of the Cerebrum.

When a horizontal slice an inch or so thick is removed from the upper surface of one hemisphere, the cut surface shows a central, oval, white

portion surrounded, on the exterior, by a serrated grayish border; this is known as the centrum ovale minus. When both hemispheres have been cut to the same level, and this level corresponds to the depth of the central portion of the longitudinal fissure, two centra ovalia minora are produced, connected in the centre by transverse fibres, forming a connecting band, called the corpus callosum; and the whole appearance, formed by the two centra ovalia minora and the corpus callosum, is called the centrum ovale majus.

Corpus Callosum.

The corpus callosum consists almost entirely of transverse fibres passing from one hemisphere to the other. Upon its upper surface there is a shallow groove, extending from before backward along the middle line, called the raphé; bordering each side of the raphé is a slight ridge produced by a bundle of longitudinal fibres, the two ridges being called the nerves of Lancisi. External to these are seen a few other longitudinal fibres, producing slight ridges which are called the lateral longitudinal striæ. When the corpus callosum is bisected longitudinally it is seen to be about four inches long and to bend vertically downward both in front and behind. The bent, rounded, posterior extremity is called the splenium, or pad, or bulb, the central portion the body, and the anterior bent portion the genu, which turns backward beneath the body for a short distance under the name of the rostrum. The rostrum divides into two cords called peduncles, which pass downward and backward to the base of the brain. Contained in the substance of the brain, between its base and the corpus callosum, is an irregular cavity divided into several parts, two of which are known as the lateral ventricles, while the space is spoken of as the general ventricular cavity.

Lateral Ventricle.

The corpus callosum forms the roof of the ventricular cavity which is divided into two similar parts by a median septum, each part being called a lateral ventricle, right and left. The right ventricle is sometimes called the first and the left the second. When the corpus callosum has been removed the floor of the lateral ventricle is brought into view. It is formed by various objects. In front, and external, is an oblong grayish mass, with its large end in front, called the corpus striatum; internal to this, and lying against its inner aspect, is a narrow white band known as the tenia semicircularis, or horny band of Tarinus; just within this is seen a small portion of an olive shaped, white body called the optic thalamus; while internal to and behind this is a small bundle of blood vessels run-

ning from behind forward, and gathered into a round cord, called the choroid plexus. The choroid plexus runs along the edge of the most internal object seen in the ventricle, the fornix. The fornix forms the inner portion of the floor of each ventricle and rises to a ridge on the centre, which ridge touches the lower surface of the corpus callosum and thus forms the septum between the two ventricles. The fornix is triangular in shape, its small end, which is in front, terminating in two cords called the crura, which pass downward to the corpora albicantia and, touching their inner aspect, then ascend to the optic thalami. Behind, the edges of the fornix are continued towards the base of the brain in a tortuous course under the name of the corpora fimbriata.

The cavity of the lateral ventricle is prolonged forward by a small triangular cavity called the anterior cornu. Posteriorly it presents a larger longer prolongation called the posterior cornu; and besides these two there is a large cavity called the middle, or descending cornu, into which the corpus fimbriatum disappears. The middle, or descending cornu begins just where the posterior cornu joins the body of the ventricle, and its direction is tortuously downward. It first runs outward and backward, then downward, forward and inward. The objects seen in it are as follows: Mounting up through it is the bundle of blood vessels, called the choroid plexus, these vessels having entered the bottom of the cornu. The corpus fimbriatum, the continuation of the posterior angle of the fornix disappears as a white band which follows the course of the cornu to the base of the brain. In this cornu is seen a ridge which, following the course of the cornu terminates at its bottom in an enlargment called the pes hippocampi, the ridge itself being called the hippocampus major. Just where the descending and posterior cornua communicate with the body of the ventricle, there is a projection between the two cornua called the pes accessorius, to which the hippocampus major leads, from the descending cornu, and to which a similar but smaller ridge, the hippocampus minor, seen on the bottom of the posterior cornu, also leads. The septum between the two lateral ventricles is the ridged centre of the fornix; but since the fornix is too short to reach to the anterior extremity of the ventricle, the septum between the two ventricles is completed in front for a short distance by a double-layered membrane called the septum lucidum, between the two layers of which membrane there is a minute interval, called the fifth ventricle.

After examining the lateral ventricle we cut away the fornix and choroid plexuses and expose just beneath them, another cavity called the third ventricle. This cavity lies between the optic thalami which form its sides. Its floor corresponds to the six sided space at the base of the

brain; its roof was the fornix; its anterior boundary a white band passing between the two corpora striata called the anterior commissure; its posterior boundary another white band, passing between the optic thalami, called the posterior commissure. Crossing the centre of the cavity, also between the optic thalami, is a third band called the soft commissure. The space in front of the soft commissure is sometimes called the foramen commune anterius, and that behind the foramen commune posterius.

In this ventricle four openings may be seen, viz: 1st, on the front of the floor is a canal which leads to the infundibulum—iter ad infundibulum; 2d, on the front of the roof are two small openings, one on each side of the middle line, the foramen of Munro, which exists for the purpose of allowing the choroid plexuses to pass from the lateral ventricles to the third ventricle.

The choroid plexus of each lateral ventricle, as has been seen, consists of a rounded mass of small arteries which perforate the bottom of the middle cornu, pass upward through the descending cornu, collecting into a bundle, which runs forward beside the fornix and, reaching its anterior extremity, disappears by notching the edge of the fornix and enters the third ventricle, where it meets its fellow on the lower surface of the fornix and the two immediately spread out so as to form a membrane-like layer of vessels which covers the lower surface of the fornix and forms the true roof of the third ventricle. This layer is known as the velum interpositum. The fourth opening into the third ventricle is seen behind, just beneath the posterior commissure, and leads backwards and downwards to another cavity called the fourth ventricle, which is found between the cerebellum and the medulla oblongata. The communication between the third and fourth ventricles is called the aqueduct of Sylvius—iter a tertio ad quartum ventriculum. Dissecting up the optic thalami we see on the lower surface of each, posteriorly, two small oblong bodies, one lying internal to the other and separated by the optic tract which passes between them. The outer of these bodies is called the corpus geniculatum externum, the inner, the corpus geniculatum internum. Immediately behind the third ventricle, over the aqueduct of Sylvius and beneath the bulb of the corpus callosum, there are two pairs of elevations collectively called the corpora quadrigemina. These elevations are arranged as follows: two in front, one on each side of the middle line, called the nates; and two behind, one on each side of the middle line, called the testes. Passing outward and forward to the optic thalamus from each side of the corpora quadrigemina are two bands, or ridges, one from the nates, called brachium anterius, and one from the testes, called brachium posterius. Lying between the nates is a small,

conical, reddish projection called the pineal gland, which has a cavity in its interior containing a little viscid fluid and a small quantity of gritty matter. It is held in place by four peduncles, or cords, two passing downward from the base of the gland to the optic thalami; and two passing forward, one on each side of the middle line, skirting the inner aspect of the optic thalami, along the lateral wall of the third ventricle, to the crura of the fornix.

Convolutions of the Cerebrum.

In studying the convolutions we begin with the principal fissures of which there are five, viz: 1st, the great longitudinal fissure, separating the two hemispheres; 2d, the great transverse fissure of Bichat, between the cerebrum and cerebellum, which admits the pia mater into the interior of the brain; 3d, the fissure of Sylvius; 4th, the fissure of Rolando; 5th, the parieto-occipital fissure.

The fissure of Sylvius begins at the anterior perforated space and passes outward to the external surface of the hemisphere and divides into two branches; one, passing upward towards the longitudinal fissure, is termed the ascending limb; the other, running nearly backward, the horizontal limb.

The fissure of Rolando, situated about the middle of the outer surface of the hemisphere, begins near the longitudinal fissure and runs downward and forward to terminate just above the horizontal limb of the fissure of Sylvius. It forms a knee-like bend in its course.

The parieto-occipital fissure is seen but slightly on the outer surface of the hemisphere. It serves to separate the parietal and occipital lobes and is distinctly marked on the internal face of the hemisphere.

By these fissure the hemisphere is divided into five lobes—frontal, parietal, occipital, temporo-sphenoidal and the central, or island of Reil.

The frontal lobe is situated in front of the fissure of Rolando and above the fissure of Sylvius. Its lower surface rests on the orbital plate of the frontal bone.

The parietal lobe is bounded in front by the fissure of Rolando, behind by the parieto-occipital fissure and below by the horizontal limb of the fissure of Sylvius, which separates it from the temporo-sphenoidal lobe.

The occipital lobe is situated at the posterior extremity of the brain, separated from the parietal, partially, by the external part of the parieto-occipital fissure, while below its convolutions pass directly into the temporo-sphenoidal lobe.

The temporo-sphenoidal lobe is lodged in the middle fossa of the skull. It is limited in front and above by the fissure of Sylvius; behind it is connected with the parietal and occipital lobes by connecting convolutions.

The island of Reil is situated in the fissure of Sylvius at the base of the brain, hidden under the fused lower ends of the ascending frontal and parietal convolutions, known as the operculum.

Convolutions.

The precentral, or vertical fissure runs upward through the frontal lobe, cutting off a convolution, which lies between it and the fissure of Rolando, called the ascending frontal convolution. The ascending parietal and ascending frontal convolutions are continuous around the lower end of the fissure of Rolando. The remainder of the outer surface of this lobe is divided into three convolutions by two antero-posterior sulci, called first and second frontal sulci. The convolutions thus cut off are known as first, second and third frontal convolutions, numbered from above downward, and are continuous with the convolutions on the orbital or lower surface, which are marked off by two sulci, the most internal of which is the groove for the olfactory nerve.

The parietal lobe presents an ascending parietal convolution, corresponding to the ascending frontal, which is limited in front by the fissure of Rolando and behind by the interparietal fissure. The interparietal fissure first ascends just behind the fissure of Rolando and then runs backward and cuts off a convolution which borders the longitudinal fissure and is called the superior parietal convolution. The remainder of this lobe is divided into two convolutions by a vertical fissure, the convolution in front being called the supra-marginal and that behind the angular. The latter is joined to the temporo-sphenoidal and occipital lobes by small connecting convolutions.

The occipital lobe is imperfectly divided, by two small, transverse fissures, into three convolutions, numbered from above downward and called first, second and third occipital convolutions.

The temporo-sphenoidal lobe has on its outer surface three convolutions, cut off by two antero-posterior fissures, numbered from above downward and called first, second and third temporo-sphenoidal convolutions; while on its lower surface are two more, divided from each other by the occipito-temporal, or collateral sulcus. They are the fusiform and lingual lobules.

On the inner surface of the hemisphere the convolutions are not con-

fined to lobes and are less complex. There are five fissures, the calloso-marginal, parieto-occipital, calcarine, collateral and dentate.

The calloso-marginal sulcus begins beneath the rostrum of the corpus callosum, winds around its genu, runs backward parallel with its body about half the length of the hemisphere and then turns upward to reach the margin of the hemisphere near the fissure of Rolando.

The parieto-occipital fissure extends downward and forward to join the calcarine fissure, just behind the body of the corpus callosum.

The calcarine fissure commences by two branches at the back of the hemisphere, runs nearly horizontally forward and is joined by the parieto-occipital fissure and continued forward as far as the posterior inferior extremity of the gyrus fornicatus.

The collateral, or occipito-temporal fissure runs forward from the posterior extremity of the brain nearly as far as the commencement of the fissure of Sylvius.

The dentate fissure, or sulcus hippocampi commences below the posterior extremity of the corpus callosum, and runs forward to terminate at the recurved part, or hook of the uncinate gyrus.

The convolutions marked off by these fissures are the gyrus fornicatus, marginal, quadrate, cuneate, uncinate and temporo-sphenoidal.

The gyrus fornicatus begins near the anterior perforated space, wind around the genu of the corpus callosum, passes along its body, winds around its bulb, under the name of the gyrus hippocampi and terminates as the uncinate gyrus nearly where it begins.

The marginal is the inner aspect of the first frontal convolution. It commences at the anterior perforated space, runs along the margin of the longitudinal fissure, on the orbital surface of the frontal lobe, bounded externally by the sulcus for the olfactory nerve, turns upward to the upper surface of the hemisphere and ceases where the calloso-marginal sulcus reaches the upper surface of the hemisphere. It is separated by this sulcus from the gyrus fornicatus.

The quadrate lobule, or precuneus, lies between the calloso-marginal fissure in front and the parieto-occipito behind.

The cuneus is situated between the parieto-occipital and calcarine fissures and is triangular in shape.

The uncinate gyrus is the anterior inferior termination of the gyrus fornicatus, with which it is connected by the gyrus hippocampi. It extends as far as the fissure of Sylvius and is bounded above by the dentate fissure and below by the collateral fissure which separates it from the temporo-sphenoidal lobe.

The convolutions of the temporo-sphenoidal lobe have been described.

The Cerebellum.

The cerebellum is only one-eighth the size of the cerebrum and is found in the inferior occipital fossæ, lying beneath the occipital lobes of the cerebrum, from which it is separated by the tentorium. The appearance of its surface differs from that of the cerebrum in not being convoluted, but is marked by numerous more or less curved furrows or sulci between which are plate-like parts of the brain substance called laminæ, hence the surface is said to be laminated. It is oblong in shape, its greatest diameter, which is the transverse, measuring four inches. It is divided into two hemispheres by a ridge above, called the vermis superior, which extends along the middle line from a notch in the anterior edge, called incisura anterior, to another notch in the centre of the posterior border, called incisura posterior. On the lower aspect the two hemispheres are separated, or rather the separation is indicated, by a groove, broad and shallow, extending from the anterior to the posterior notch and called the valley. Running along the bottom of this groove is another ridge, called vermis inferior.

When a vertical antero-posterior section of either hemisphere is made an appearance is produced, called arbor vitæ, which resembles the trunk of a tree with some ten or twelve branches. The trunk is white and placed horizontally in front; the branches, which are also white, diverge from the trunk superiorly, inferiorly and posteriorly. The surrounding substance is gray. A little above and behind the centre of the trunk is an irregular mass of gray matter, called the corpus dentatum.

Beneath the cerebellum, between it and the posterior aspect of the medulla oblongata, is the fourth ventricle. It is lozonge-shaped—triangular in vertical section—and its boundaries are as follows: Its floor is the calamus scriptorius of the medulla; its roof is formed by two elements, the lower, posterior part is the cerebellum; the front part is the membrane like layer, called the valve of the brain, or valve of Vieussens; each side is formed by a thick cord passing from the cerebellum to the testes and called processus e cerebello ad testes. The ventricle is closed behind and below by a fold of pia mater as it passes from the medulla to the cerebellum.

On the floor of the ventricle are two rounded oblong ridges called fasciculi teretes. Crossing these, as they are passing from the posterior median fissure outward, are the fibres of origin of the eighth, or auditory nerve; these fibres, being white and running transversely, are called lineæ transversæ. On that portion of the roof formed by the cerebellum there are four projections, one in front, on the middle line, called the mo-

dulus, one just behind this called the uvula and one each side of the uvula, called amygdala or tonsil. Communicating with the front upper extremity of the ventricle is the aqueduct of Sylvius, which passes upward and forward beneath the corpora quadrigemina to the back part of the third ventricle. The fourth ventricle was called by the older anatomists the first, since it was more easily reached and more constant in its existence in the different natural orders.

The different parts of the brain are connected, generally by white fibres, in order to harmonize the action of the different parts. The two hemispheres of the cerebrum and their subdivisions, are connected across the middle line by—1st, the corpus callosum; 2d, the anterior commissure; 3d, the middle commissure; 4th, the posterior commissure. The different parts of the same hemisphere are connected by white fibres which pass from before backward, as the crura of the fornix, the tœnia semicircularis, the brachium anterius, brachium posterius, &c.

The two hemispheres of the cerebellum are connected by the vermis superior and inferior, by the transverse fibres of the pons Varolii, which, leaving the anterior part of one hemisphere under the name of crus cerebelli, a thick white cord, pass across, forming the transverse fibres of the pons, and enter the other hemisphere as the other crus.

The two sides of the medulla oblongata are connected by a central commissure, like the spinal cord, and by a decussation of the anterior pyramids across the anterior median fissure.

The cerebellum is connected to the cerebrum by the two processus e cerebello ad testes. The medulla is connected to the cerebellum by the corpora restiformia which pass to it as processus ad medullam oblongatam. It is connected to each hemisphere of the cerebrum by one of the two crura cerebri which, as has has been seen, form the longitudinal fibres of the pons and emerge from it to reach the cerebrum.

THE ORGAN OF HEARING.

The organ of hearing is connected with the temporal bone of each side, and properly speaking, consists of two organs, one to each side. In the prepared bone a portion is still preserved, for upon the base of the petrous portion of the temporal bone the bony portion of the external auditory meatus is seen; and on the posterior surface of the petrous portion the internal auditory meatus, at the bottom of which is seen the internal wall of the inner chamber perforated by numerous apertures. The external wall of the inner chamber is seen by looking into the external auditory meatus. On the anterior face of the petrous portion are seen the bulge of the superior semicircular canal and just external to this a depression corresponding to the roof of the middle chamber, or tympanum, the floor of which is the jugular fossa, on the basilar face of the petrous portion of the temporal.

The organ of hearing is described as consisting of three portions, or chambers, lying the one internal to the other, upon the base and in the substance of the petrous portion of the temporal bone. These three chambers are known from without inward as—1st, external ear consisting of three portions, (*a*) pinna, or auricle; (*b*) meatus auditorius externus; (*c*) membrana tympani; 2d, middle ear or tympanum; 3d, internal ear, or labyrinth.

The External Ear.

The external ear consists of three portions named above. Its function is to connect the sonorous vibrations and convey them to the middle ear, which in turn transmits them to the internal ear, where they encounter the sentient nerve of hearing.

The pinna, or auricle is the expanded outer extremity of the external chamber found on the base of the petrous portion of the temporal bone, contracting to its termination in the external auditory meatus. It presents a very uneven surface and the various elevations and depressions have received individual names. The central concavity, leading to the external auditory meatus, is called the concha; the more or less folded margin, or rim, the helix; the pendant, lower, softer portion, the lobulus; the triangular prominence jutting out in front of the concha, the tragus; behind and somewhat below this separated from it by a notch, is another projection, the antitragus; the curved elevation between the helix and the concha, or rather behind the concha, is the anti-helix, which divides superiorly enclosing a depression called the fossa ovalis; the deeply

sunken surface between the helix and the anti-helix is the fossa scaphoidea, or innominata.

The pinna varies greatly in different people, and this is especially true of the lobule. In structure it consists of a plate of fibro-cartilage, whose folds produce the depressions and elevations mentioned. This cartilage is covered by integument and alveolar tissue, supporting various insignificant muscles, intrinsic, intended to vary its shape, and giving attachment to other small muscles, extrinsic, intended to move the pinna. Of the latter some few people have use, but the former never act to produce visible effect. The cartilage is not continuous throughout the auricle, for it is altogether wanting in the lobule and, besides, presents several fissures which have received names. The pinna is held in position by the integument, by the extrinsic muscles mentioned above and by two ligaments, anterior and posterior. The anterior extends from the helix to the zygoma; the posterior, from the concha to the mastoid process. Besides these there are several small ligaments passing from one part of the cartilage to another, the largest of which is that between the tragus and helix.

The external auditory meatus is the canal which extends from the concha to the tympanum, from which it is separated by the tympanic membrane. It is rather more than an inch in length, its direction being inward and slightly forward and its course somewhat curved, with its convexity upward. It is smaller in the centre than at either end. It consists of an external cartilaginous portion, taking up one-third of its length, and an internal, osseous portion, taking the remaining two-thirds. The osseous portion terminates internally at an oblique groove for the attachment of the membrana tympani. This portion can be seen in the dried bone, although the septum in the bottom is of course absent. The outer extremity is rough and prominent for the attachment of the cartilaginous portion. It is lined throughout by the integument which, toward the exterior, is studded with hairs and contains glands for the secretion of the ear wax. The hairs and wax are intended to obstruct the entrance of insects, &c.

The membrana tympani is the septum separating the external from the middle chamber, being situated at the inner extremity of the external auditory meatus, attached to the oblique groove there found. It is fragile, semi-transparent, nearly round, oblique in its direction from above downward and inward, striking the floor at an angle of 45°, and is seen to bulge toward the tympanum, having a corresponding concavity externally. Its frame work is fibro-elastic, consisting of radiating and concentric fibres, the latter especially seen near its circumference; it is

covered externally by the integument lining the external auditory meatus, which is exceedingly sensitive. Internally it is coated by the mucous membrane of the tympanum.

The Middle Ear.

The middle ear, chamber, or tympanum, lies in the petrous portion of the temporal bone, separated, externally, from the meatus auditorius externus by the membrana tympani; and separated, internally, from the inner chamber, or labyrinth by a bony wall and its roof corresponds to the depression on the anterior face of the petrous bone, its floor to the jugular fossa on the basilar face of that bone. Its anterior wall is a bony partition interposed between it and the internal carotid artery and its posterior wall is the cellular substance of the mastoid portion of the temporal bone. Owing to the obliquity of the inner and outer walls, the tympanum is much narrower transversely, below than above. The length of its roof from without inward is about three lines, the floor being scarcely more than one line. It presents for examination six walls, two of which—floor and roof—have nothing noteworty. The outer wall has been described as the membrana tympani, having attached to it a chain of bones, which extends to the inner wall.

The internal wall is the bony partition between the tympanum and the labyrinth, upon which are seen the following appearances: (*a*) a ridge at its upper part corresponding to the aqueduct of Fallopius; (*b*) just beneath this a kidney-shaped aperture, opening into one of the apartments of the labyrinth, called the fenestra ovalis. This is closed during life by a membrane to which is attached the foot of the stapes; (*c*) below this is a bulging surface known as the promontory; (*d*) beneath this is a second opening oval, or triangular in shape, called the fenestra rotunda, which is likewise closed by a membrane and establishes communication with another part of the labyrinth called the cochlea.

The posterior wall presents several small openings into the mastoid cells and the opening for the entrance of the chorda tympani, iter chordæ posterius, which crosses the tympanum to gain exit on its anterior wall. There is also a conical projection, the pyramid, which has at its summit an opening for the stapedius muscle.

On the anterior wall are seen: (*a*) the fissure of Glaser; (*b*) the opening of exit of the chorda tympani, iter chordæ anterius, or canal of Huguier; (*c*) two small openings, separated by a thin plate of bone, the upper called the opening for the tensor tympani, the lower the opening for the Eustachian tube, and the dividing septum the cochleariform process. Stretching across the tympanum from the membrana tympani,

externally, to the fenestra ovalis internally are seen three small bones, malleus, incus and stapes. The malleus is the outermost of the three, resting against the membrana tympani externally and articulating with the incus internally. It consists of a head, for articulation with the incus, a neck and three processes. One of the processes is called the handle, manubrium, and lies embedded in the membrana tympani, half way to the floor from above downward. Another, the long process, processus gracilis, passes downward to the fissure of Glaser; while the third, the short process, bulges outward from the neck. The incus is so called from its resemblance to an anvil. It consists of a body, for articulation with the head of the malleus, and two processes. The short process passes backward to the opening of the mastoid cells in the posterior wall; the long, passes downward to articulate with the head of the stapes, terminating in an enlargement, called the os orbiculare. The stapes, stirrup, projects inward from the os orbiculare, with which it articulates by a head. Succeeding the head comes the neck and diverging from this are the two crura, one to either side, which are connected at their distal extremity by a plate, called the foot, which is exactly fitted into the fenestra ovalis. When the child is born those bones have attained nearly their full size. They are held together by ligaments and give attachment to several small muscles which are intended to move the bones on one another and thus relax, or tighten the membrana tympani, or the membrane of the fenestra ovalis. This latter membrane is in fact composed of two layers, and the fenestra ovalis is closed successively by the following parts from without inward, viz: 1st, the mucous membrane of the tympanum; 2d, beneath this the foot of the stirrup; 3d, on the labyrinthine surface this foot is coated by the serous membrane lining the labyrinth. The arrangement for closing the fenestra rotunda is similar in consisting of three elements: (1st), a fibrous membrane coated by (2d) the mucous membrane of the tympanum externally and (3d) internally by the serous membrane of the labyrinth. It is constructed so much like the membrana tympani that it has been called the membrana tympani secundaria. The ossicula auditus are held to one another and in position by means of small ligaments. The head of the malleus is held to the body of the incus by a capsular ligament; and another capsular ligament binds together the os orbicularis and the head of the stapes. The ligaments holding the bones together are three in number: 1st, the foot of the stapes is held to the fenestra ovalis by means of ligamentous fibres; 2d, there is a suspensory ligament of the malleus consisting of a few ligamentous fibres passing between its head and the roof of the tympanum; 3d, a band of fibres attaches the short process of the incus to

the opening of the mastoid cells. These bones, thus permitted motion by means of the ligaments, are moved not only by the vibrations of the membrana tympani but by two small muscles, viz: The tensor tympani which springs from the apex of the basilar surface of the petrous bone and the upper aspect of the cartilaginous portion of the Eustachian tube and enters the opening in the tympanum known by its name, and found just above the processus cochleariformis, which separates it from the opening of the Eustachian tube; it also derives a few fibres from the canal it traverses. When it reaches the anterior wall of the tympanum its tendon turns outward and is inserted into the malleus at the junction of the manubrium and long process of the malleus. The stapedius is far the smallest muscle in the body. It arises within the hollow pyramid, on the posterior wall of the tympanum, emerges from the opening on the summit of the pyramid and is inserted by a tendon into the neck of the stapes. The action of the stapedius is to regulate the pressure of the foot of the stapes against the fenestra ovalis.

The Eustachian Tube.

The Eustachian tube is a canal, which establishes communication between the air in the tympanum and the outside atmosphere. It passes from the anterior wall of the tympanum, where its opening is seen just beneath the processus cochleariformis, downward, forward and inward, to terminate in the pharynx, just behind the opening of the posterior nares. Its lower third is cartilaginous; its upper two-thirds osseous.

The Internal Ear.

The internal ear, or labyrinth is the innermost of the three chambers, which constitute the organ of hearing and is intended for the terminal ramifications of the auditory nerve, which reaches it through the internal auditory meatus, on the centre of the posterior face of the petrous bone, and for the reception of the communicated vibrations of air, which reach it through the tympanum. It consists of an osseous and a membranous labyrinth, the osseous being divided into three chambers, which, however, communicate with one another. These three parts are placed one behind the other: the anterior is called the cochlea, the middle the vestibule, the posterior the three semicircular canals. They are all lined by a serous coat.

The Vestibule.

The vestibule is a three cornered cavity, having communication with the tympanum through the fenestra ovalis. Each corner is called a ventricle

and the three are known as anterior, superior and posterior. In the anterior are seen the following objects · 1st, a depression, called fovea hemispherica; 2d, a number of minute apertures, called the macula cribrosa; 3d, a ridge, the eminentia pyramidalis; 4th, the opening into the cochlea, scala vestibule. In the superior we have: 1st, a depression—the fovea hemi-elliptica; 2d, the two openings of semicircular canals—the dilated extremities of the superior and horizontal. The posterior presents: 1st, a depression—fovea sulciformis; 2d, the opening of the aqueduct of the vestibule; 3d, the dilated extremity of the oblique semicircular canal, the common aperture for this canal and the superior and the opening of the horizontal canal.

The Semicircular Canals.

These canals are channels hollowed in the petrous portion of the temporal bone. They are three in number, each about one-twentieth of an inch in diameter, and placed at right angles to one another. Each forms rather more than a semicircle and presents near one extremity an enlargement, called the ampulla, and opens by both ends into the vestibule, The three canals are called: 1st, superior, which is vertical in direction and produces the ridge seen on the anterior face of the petrous bone; 2d, the posterior, or oblique, which is also vertical; 3d, the external, or horizontal. These three canals present but five openings into the vestibule, owing to the fact that the posterior and superior have a common opening into the posterior corner of the vestibule. The other openings were mentioned in the description of the vestibule—three being into the poserior and two into the superior corner.

The Cochlea.

The cochlea lies in front of the vestibule and by its base forms the promontory, seen on the inner wall of the tympanum. When entire it resembles a snail's shell and may be described as consisting of a tube divided into two apartments by a longitudinal septum, one end of the tube being closed and much smaller than the open end from which it rapidly tapers. The septum is not complete, for it fails to reach to the small, closed end, thus allowing a communication between the two chambers. This tube is coiled by two turns and a half around a stem, or tapering pillar, called the modiolus. The septum subdividing the two chambers, which are called scalæ, is named the lamina spiralis. It consists of two layers, between which is a narrow space, called scala media,

and it terminates in a hook-like projection, called the hamulus. When examined closely the lamina spiralis is seen to consist of three structures: the portion next the modiolus is bony, farther out it is membranous and the outermost portion is muscular and sometimes called the cochlearis muscle. The small space, existing between the extremity of the lamina spiralis and the cupola, is called the helicotrema; it establishes communication between the two chambers, one of which is called the scala tympani, the other the scala vestibuli. The scala vestibuli is seen to communicate, at the base of the cochlea, next the vestibule, with the anterior corner of the vestibule. The scala tympani communicates with the tympanum, by means of the fenestra rotunda. The modiolus is the tapering pillar around which the two scalæ wind. In its centre there is a canal called the tubulus centralis modioli. Its base is next the vestibule.

The Membranous Labyrinth.

Besides the parts above described, the labyrinth contains others, for within each semicircular canal is a membranous counter part, two-thirds smaller, separated from the bony wall by liquid. The membranous canals present the same dilations at one end, ampulla, as the bony.

In the vestibule also are two membranous sacs, one above the other. The upper one receives the openings of all the semicircular canals and lies in the fovea hemi-elliptica. It is called utriculus, or sacculus proprius. In the membranous labyrinth, as the above parts are collectively called, are found crystalline particles, carbonate and phosphate of lime, called ear-dust, or otoliths.

The auditory nerve gains the labyrinth through the internal auditory meatus. At the bottom it divides into a vestibular and a cochlear branch, the latter dividing into filaments which run in channels in the modiolus and turn outward to ramify in the lamina spiralis. The vestibular branch divides into three, one for each of the membranous sacs, and one for the semicircular canals.

THE ORGAN OF VISION.

The organ of vision is situated in the orbits, two conical cavities found on the face. Like the organ of hearing, it consists of two similar portions, one on each side, called the eye-ball and its appendages.

The Appendages of the Eye.

The appendages of the eye, tutamina oculi, are mere accessories to the true organ of vision, the eye-ball, for the purpose of protection and ornament. They are:

I. Eyebrow is a prominence of the integument, curved, covered with hair and situated above each orbit. They are intended for ornament and protection from dust, perspiration and too vivid light, and to break the force of any blow falling on the front of the orbit.

II. The eyelids consist of two movable curtains, which are constantly playing over the front of the eye-ball. The aperture, which separates the two lids, one called upper, superior palpebra, the other lower, inferior palpebra, is known as the palpebral fissure and can be extinguished, or dilated at pleasure. The two lids meet externally at an acute angle called the external canthus; internally when they seem about to meet they refrain from doing so and the interval between is prolonged inward towards the nose for some distance before forming the internal canthus. The triangular space thus left between the lids at the inner canthus is called the lachrymal lake, lacus lachrymalis, in which is seen a reddish, conical projection, called the caruncle, which is bounded externally by a curved fold of mucous membrane, called the plica semicircularis. The concavity of this fold is external.

At the commencement of the lachrymal lake, just where the two lids are apparently about to unite, there is a projection from the edge of each lid, called the lachrymal papilla, or tubercle, on the summit of each of which is an opening, the punctum lachrymale. The free edge of each lid is provided with several rows of short curved hairs, the eye-lashes, intended for ornament, to render the contact of the lids more intimate and to protect against dust, etc. In structure the eye-lids consist of the following parts: externally there is a layer of thin, loose skin with subjacent areolar tissue; internally, a layer of mucous membrane called the conjunctiva, which not only lines the inner surface of the lids, but is reflected over the front of the ball—palpebral and ocular portions. The

palpebral portion is studded with papillæ. Just beneath the integument, on the outer surface of the lid, is a pale thin muscle, the orbicularis palpebrarum, so named from the fact that it is somewhat round, passes from one lid to the other and surrounds the palpebral fissure, its function is to close the lids. Beneath the orbicularis palpebrarum, in each lid, is a curved plate of cartilage, about an inch in length, called the tarsal cartilage. The superior is the larger and is semilunar in shape; the inferior is much the narrower and oval. The two are attached along their circumference to the edge of the orbit by ligamentous fibres. Externally, they are held to the outer angle of the orbit by a ligament called the external palpebral, or tarsal ligament; internally, they terminate in a ligament, called the tendo oculi, which holds them to the edge of the orbit. Lying on the posterior surface of the lids between them and the mucous membrane, and opening on the edge of the lids is a number of vertical, beaded bodies, the Meibomian glands, the secretion from which is discharged on the edge of the lids. There are thirty of these glands for the upper lid, but a smaller number for the lower.

III. Lachrymal apparatus. Lying in the depression, seen on the orbital plate of the frontal bone, just behind the external angular process, is the lachrymal gland. It is about the size and shape of an almond and rests on the posterior part of the upper tarsal cartilage. The ducts, seven to twelve in number, which convey the secretion of the gland, tears, being discharged on the surface of the conjunctiva, is constantly swept toward the inner canthus of the eye by the frequent movement of the lid; there it disappears in the lachrymal puncta from each of which there leads a small canal called the lachrymal canaliculi. The upper first ascends then bends inward to terminate in the nasal, or lachrymal duct; the lower first descends, then turns inward to terminate in the nasal duct beside the superior. The nasal duct extends a little way above the openings of the canaliculi in a portion, called the lachrymal sac; and from this point the duct extends downward, outward and slightly backward to terminate in the inferior meatus of the nose.

The Globe of the Eye.

The eye-ball is situated in the front part of the orbit, embedded in a mass of fat. It is nearly globular, its antero-posterior diameter being one inch and its transverse seven-twelfths of an inch. Posteriorly it receives the optic nerve, at a point about one one-tenth of an inch to the nasal side of the centre. The ball consists of concentric layers en-

closing a bag of liquid, which forms about four-fifths of it. These coats or layers are sclerotic, choroid and retina.

The Sclerotic Coat.

The sclerotic, familiarly known as the white of the eye, is a dense fibrous membrane, which serves as a protecting envelope for the rest of the eye-ball. Its anterior one-sixth is wanting, the aperture being filled by a transparent membrane, the cornea. Posteriorly the sclerotic is perforated by the optic nerve, not en masse, for the nerve splits into a number of fibres, which pierce the coat separately, producing the appearance known as macula, or lamina cribrosa, the fibrous sheath of the nerve becoming continuous with the sclerotic, while in front the sclerotic is continuous with the cornea.

The Cornea.

The cornea forms the anterior one-sixth of the first investment of the eye-ball. It forms a segment of a smaller sphere than the sclerotic and being more convex it causes the increase of the antero-posterior diameter over the transverse. The cornea, instead of being opaque, like the sclerotic, is transparent and its circumference is received beneath the anterior bevelled edge of the sclerotic with which it is continuous in some of the structures. It consists of five layers. The anterior surface is an epithelial layer, derived from the conjunctiva; the posterior layer is also epithelial, the lining membrane of the anterior chamber. Next each of these is found a layer of elastic tissue, the two layers constituting what is called the elastic cornea, and separating these is a layer of fibrous tissue, called the cornea propria, which can be split into sixty layers of spindle-shaped cells with branching intervals, in which circulates the colorless plasma of the blood. It is with this cornea propria that the sclerotic is continuous. The cornea is of varying convexity in different people and at different periods of life. It is more convex in youth and becomes less so in old age, at which period there is often seen around the cornea a yellowish band, called arcus senilis.

The Choroid.

The choroid lies within the sclerotic, with which it is connected by areolar tissue, sometimes called lamina fusca, which is pierced by the optic nerve. At the point in front where the sclerotic ceases the choroid terminates in a flattened membrane, the iris, which, in its centre presents a round aperture, the pupil. The choroid consists of three layers, the

outer two red and the inner black. Between the two red and the black layers some make a fourth layer, the membrana limitans. The external red layer is called the venous layer; the internal red layer the capillary, arterial, layer, or the tunica Ruyschiana. The internal layer, or membrana pigmenti, or tapeta is of a black color, consisting of cells, filled with coloring matter. On the anterior surface of the choroid, just around its anterior margin, is a whitish band, one-fortieth of an inch wide, called the ciliary ligament, which binds together the cornea and sclerotic and the choroid and iris. Extending back, about one-eighth of an inch, on the anterior aspect of the choroid, is a gray circular band, called the ciliary muscle. On the posterior aspect of the front of the choroid are, about, sixty ridges, diverging from the rim of the choroid, called the ciliary processes.

The Iris.

The iris is the thin, flat membrane, which continues the choroid in front. In its centre is seen the opening, called the pupil. The various colors of the iris are due to the difference of color of the pigmentary matter found in its cells and to the varying arrangement of the blood vessels. The color is darkest usually near the centre.

Towards the middle of the iris is a circle of little shaggy projections. The foundation of the structure of the iris is fibrous tissue, consisting of circular and radiating fibres, interposed between which are pigment cells. In front and behind this fibrous layer is a layer of pigment cells. In the iris are also seen unstriated muscular fibres, circular around the pupil and radiating toward the circumference: by the action of these fibres the pupil is constantly dilating and contracting. Blood vessels and nerves ramify throughout the structure. On the posterior surface the iris consists of a black layer, called the uvea, which is, in fact, a continuation of the membrana pigmenta of the choroid.

Anterior Chamber—Between the iris and pupil behind, and the cornea in front is a small cavity, called the anterior chamber.

Posterior Chamber—Between the iris and pupil in front, and the lens behind is another, smaller cavity, called the posterior chamber. These two contain a liquid, called the aqueous humor, and they communicate through the pupil, after the sixth month of fœtal life, up to which time the pupil is closed by a membrane, called the papillary. Both chambers are lined by a membrane which secretes the aqueous humor.

The Retina.

The retina is the innermost of the three coats of the eye, lying

just within the choroid. It is wanting in front even for a greater distance than the two preceding layers, for it ceases, as it reaches the ciliary processes, in a rough, ragged margin, called ora serrata, and is continued thence to the crystalline lens by a vascular membrane, called the suspensory ligament of the lens. The outer surface of the ligament is fluted to correspond with the ciliary processes, against which it rests.

The retina is non-resisting and translucent, being partially formed by the expansion of the optic nerve, with which it is continuous posteriorly.

Exactly in the centre, posteriorly, is a round, yellowish spot, called the macula lutea, and in the centre of this spot a depression called fovea centralis. About one-tenth of an inch to the inner side of this is seen the termination of the optic nerve—optic disk, or papilla—showing in its centre the arteria centralis retinæ, breaking up into branches. From this point forward the retina gradually thins to its termination.

The Vitreous Humor.

Just within the retina is a bag, called the hyaloid membrane, containing a liquid, called vitreous humor. This is similar in composition to the aqueous humor, being 98% water. Traversing the centre of this, in the fœtus, is a branch of the arteria centralis retinæ, making its way to the lens, called the capsular artery. It disappears at birth.

The Crystalline Lens.

Indenting the front of the hyaloid membrane is found a doubly convex transparent body, called the crystalline lens. Its posterior surface is much more convex than the anterior, the latter forming the posterior wall of the posterior chamber. The lens forms only the bulging portion of the wall, the circumference of which is formed by the suspensory ligament of the lens, which extends from the ora serrata of the retina to the rim of the lens. This ligament is formed of two layers and when it lays hold of the lens it leaves a circular canal around it, called the canal of Petit. The lens is invested by a transparent homogeneous, elastic membrane, the capsule of the lens. In structure the lens consists of a series of concentric layers of parallel fibres, which gradually harden towards the centre of the lens. It can also be split into three triangular segments, which meet by their apices in the centre of the lens.

In youth the lens is more convex and much softer than in old age, as it gradually becomes, with advancing life, firmer and less convex.

THE MUSCULAR SYSTEM.

When an incission is made in any part of the body, the following structures, from without inward, are met with: 1st, skin; 2d, superficial areolar fascia, whose existence allows the free movement observed in almost every part of the integument. It consists of two layers, between which is generally found fatty tissue, varying in quantity in different parts of the body; 3d, beneath the superficial fascia, in some parts of the body, are found the muscles with their proper investing fascia; while in others there is interposed between them and the superficial fascia a strong, and more or less thick, membrane, called the investing fascia, or deep fascia which frequently gives off from its deep face partitions, which separate different groups of muscles.

The function of muscles is to produce movement, most of them being attached to bone, some having no bony attachment, while others are attached to bone by one extremity the other terminating in some soft tissue. When a muscle is attached to bone by both extremities a movable joint is almost invariably found between the two extremities, otherwise no movement would occur when the muscle attempted to contract, so that, as a rule, those muscles, which lay hold of bone at both extremities, are attached to different bones at either end. The two attachments of a muscle are spoken of, one as the origin, the other as the insertion, the origin being usually that attachment susceptible of the least motion, and as a rule, especially true of the limbs, the origin is the point nearest the body, or the mid-line of the body. The action of a muscle consists in the shortening of its length, thus drawing the parts to which it is attached nearer, usually by movement of the part into which it is inserted. Some movements are too complex to be brought about by one muscle and result from the co-ordinated action of several.

The striated muscles are the red, fleshy portion of the body, though generally a muscle consists of two parts: the red fibres, gathered into bundles, fasciculi, forming a coarse, or a fine muscle, and a white, tougher, stronger portion called its tendon. With few exceptions the tendon is found at the extremities of the muscle, and, as it is so much stronger, bulk for bulk, the tendon is much the smaller part of the muscle, thus economizing space at the attachments. The portion of muscle between its tendons of origin and insertion is called the belly of the muscle. In a few instances a muscle has two bellies, since it may have a central tendon.

The names of most muscles are derived from one of the following facts: 1st, the position which it occupies; 2d, its shape; 3d, the direction of its fibres; 4th, its attachments; 5th, its action; 6th, the number of its origins.

The Muscles of the Face.

The muscles of the face are arranged in groups, viz: those connected with the orbit, with the nose, the mouth and, a very unimportant, group connected with the auricle.

Orbital Group—Three Muscles.

Orbicularis Palpebrarum.

The orbicularis palpebrarum is an elliptical muscle, lying just beneath the skin, in front of the orbit, the portion which lies on the lid being thinner and paler than the rest. It arises from the tendo oculi and adjacent bone; and the fibres, forming an ellipse around the orbit, return to the place from which they started. The tendo oculi is a fibrous cord, which is attached by one end to the orbital aspect of the nasal process of the superior maxilla, while the other end bifurcates to be attached to the inner extremities of the tarsal cartilages.

Externally the orbicularis palpebrarum is attached to the temporal fascia.

Action—It closes the eyelids. It is one of the sphincter muscles, but in its action differs from most of them in being immovably attached at its extremities. When its fibres contract they bring the eyelids together in a line corresponding to its points of attachment, whereas most sphincter muscles close the aperture which they surround by an approximation of all their fibres at the same time, and in the same proportion, towards the centre of the aperture, *e. g.*, the orbicularis oris, in the act of whistling, since it has no bony attachment.

Corrugator Supercilii.

The corrugator supercilii is a small muscle, which arises from the inner extremity of the superciliary ridge, on each side, passes outward and is lost in the deep face of the orbicularis palpebrarum.

Action—It throws the skin of the forehead into vertical folds, *i. e.*, corrugates the brow.

Tensor Tarsi.

The tensor tarsi, or Horner's muscle, is very small. It arises from the orbital surface of the lachrymal bone, passes outward and divides into

two portions, which lay hold of the inner extremities of the lids as far out as the punctum lachrymale.

Action—It aids the orbicularis palpebrarum in closing the lids and also draws inward the puncta lachrymalia the better to receive the tears.

The Ocular Group—Seven Muscles.

The muscles forming this group are found within the orbit. All of them, except the levator palpebræ susperioris, are attached to the eye-ball, and all, except the two oblique muscles, arise at the apex of the orbit and pass forward flat, straight and widening as they advance toward their insertion.

Four of them, from the direction of their fibres, are called recti and are concerned in moving the eye-ball. They are distinguished as: 1st, superior rectus, because it lies above the eye-ball and draws the front of the eye upward; 2d, inferior rectus, because it lies below the eye-ball and draws its front downward; 3d, external rectus, because it lies external to the eye-ball and draws its front outward; 4th, internal rectus, because it lies internal to the eye-ball and draws its front inward. By a combined action of these muscles the front of the eye can be moved in all directions intermediate between those mentioned. All the recti arise from the apex of the orbit, that is the margin of the optic foramen, and also receive an origin from the fibrous sheath of the optic nerve. They run forward and are inserted into the sclerotic coat about one-fourth of an inch behind the circumference of the cornea. Some give as the origin of three of these muscles the ligament of Zinn, which is a fibrous band attached around the lower portion of the circumference of the optic foramen. This, however, is an unnecessary refinement. These muscles differ but slightly in size and length.

Superior Rectus.

The superior rectus arises from the upper margin of the optic foramen and from the fibrous sheath of the optic nerve. It passes forward and is inserted in the sclerotic coat one-fourth of an inch behind the cornea. It is the thinnest of the recti.

Inferior Rectus.

The inferior rectus arises from the lower margin of the optic foramen and from the sheath of the optic nerve. It passes forward and is inserted

into the under surface of the sclerotic about one-fourth of an inch behind the cornea.

External Rectus.

The external rectus arises by a forked origin from the outer margin of the optic foramen and from the sheath of the optic nerve. It passes forward and is inserted into the outer surface of the sclerotic coat about one-fourth of an inch behind the circumference of the cornea. It is important to remember its forked origin, since many nerves pass through the interval between its head.

Internal Rectus.

The internal rectus arises from the inner margin of the optic foramen and sheath of the optic nerve. It passes forward and is inserted into the inner surface of the sclerotic coat about one-fourth of an inch behind the circumference of the cornea.

Levator Palpebræ Superioris.

Lying just beneath the orbit, and between it and the superior rectus, is a muscle closely resembling the recti, called levator palpebræ superioris since its action is to raise the upper lid. It arises from the upper margin of the optic foramen and sheath of the optic nerve, passes forward and is inserted into the upper edge of the superior tarsal cartilage.

Inferior Oblique.

The inferior oblique is a narrow and thin muscle, arising from the orbital surface of the superior maxilla, near the inner side of the orbit. It passes out beneath the eye-ball and inferior rectus to be inserted into the sclerotic near the entrance of the optic nerve, on the outer under aspect of the eye-ball.

Action—It rotates the eye-ball on its antero-posterior axis.

Superior Oblique or Trochlearis.

The superior oblique arises from the inner margin of the optic foramen and sheath of the optic nerve. It passes forward along the upper inner wall of the orbit to its front, where, becoming tendinous, it plays through a cartilaginous ring fixed to the fovea trochlearis: thence its tendon passes outward and backward, beneath the superior rectus, to be inserted

into the outer aspect of the sclerotic about half way between the circumference of the cornea and the entrance of the optic nerve.

Action—Its action is computed from the pulley at the fovea trochlearis—hence it rotates the eye-ball on its antero-posterior axis and draws it forward.

Muscles of the Mouth.

The muscles of the mouth consist of two groups, superior and inferior labial groups and one muscle, the orbicularis oris, which belongs to both groups.

Orbicularis Oris.

The orbicularis oris is the sphincter muscle of the mouth; as it has but slight connection with bone, this attachment may be disregarded. It consists of two segments, one in each lip, which meet at the angles of the mouth.

Action—It can close the mouth in two ways, either by bringing the lips together in a horizontal line or by approximating the angles of the mouth at the same time.

Superior Labial Group—Five Muscles.

Levator Labii Susperioris Alæque Nasi.

The levator labii susperioris alæque nasi arises from the nasal process of the superior maxilla and descending divides into two slips, one of which is inserted into the ala of the nose while the other continues on to be inserted in the upper lip. Its name indicates its action.

Levator Labii Superioris Proprius.

This muscle arises from the orbital ridge of the superior maxilla and descends to be inserted into the upper lip. Its name indicates its action.

Levator Anguli Oris.

The levator anguli oris, or canine muscle, arises from the canine fossa of the superior maxilla and passes downward and outward to be inserted into the angle of the mouth. Its name indicates its action.

The *Zygomatic* Muscles—Two.

The zygomatic are two small muscles which arise from the zygomatic

process of the malar bone and pass downward and inward. The zygomaticus major, the lower one, is inserted into the angle of the mouth and the zygomaticus minor into the upper lip.

Action—They carry the angle of the mouth upward and outward.

Inferior Labial Group—Three Muscles.

Quadratus Menti.

The quadratus menti, or depressor labii inferioris, is a square-shaped thin muscle which arises from the oblique line on the front of the lower jaw near the symphysis and, passing upward, is lost in the lower lip. Its synonym indicates its action.

Triangularis.

The triangularis, or depressor anguli oris, arises by its base just external to the preceding and is inserted by its apex into the angle of the mouth. Its synonym indicates its action.

Levator Labii Inferioris.

The levator labii inferioris lies just beneath the mucous membrane. It arises from the incisive fossa of the inferior maxilla and is inserted into the integument of the chin. Its action is indicated by its name.

Cranial Group—One Muscle.

Occipito-Frontalis.

The occipito-frontalis of either side arises from the superior curved line of the occipital bone and the mastoid process. It is tendinous at its origin but becomes fleshy as it passes forward; and then, as it is mounting over the vault of the cranium, it forms a broad aponeurosis and descending on the forehead again becomes fleshy to be lost in the orbicularis palpebrarum and corrugator supercilii, its innermost fibres forming the pyramidalis nasi muscle.

Action—It raises the brows and throws the skin of the forehead into wrinkles.

Nasal Group—Three Muscles.

Pyramidalis Nasi.

The pyramidalis nasi is formed by the innermost fibres of the occipito-frontalis, which descending, are lost on the bridge of the nose.

Action—It draws down the inner extremity of the eyebrow and elevates the nose.

Compressor Naris.

The compressor naris, triangular in shape, arises from canine fossa in the superior maxilla by its apex and, mounting on the side of the nose, meets its fellow of the opposite side in a tendinous raphe on the bridge of the nose.

Action—The two are supposed to expand the nostrils.

Depressor Alæ Nasi.

The depressor alæ nasi is found just beneath the mucous membrane of the upper lip. It arises from the incisive fossa of the superior maxilla and is inserted into the ala of the nose. Its name indicates its action.

The muscles of the face are nearly all small and pale and fatty. As a rule they arise from bone and are inserted into soft parts. Their action produces the varying expression of which the face is capable.

Muscles of Mastication—Five.

These muscles produce the various movements of the lower jaw on the upper.

Masseter.

The masseter arises from the zygoma, from the lower border of the malar bone and from the malar process of the superior maxilla. It is inserted into the outer surface of the ramus of the lower jaw as far as its angle. The muscle is square in shape, its anterior fibres passing downward and backward, superficial to the posterior fibres which pass downward and forward.

Temporal.

The temporal is a radiated muscle occupying the temporal fossa. It arises from the whole of the temporal fossa, from the whole length of the temporal ridge and from the temporal fascia which covers it. It passes downward, its fibres converging, and is inserted into the apex and inner side of the coronoid process of the inferior maxilla.

Buccinator.

The buccinator, or trumpeter's muscle, is the bulkiest element of the cheek. It arises from the alveolar process of the superior maxilla, from

the external oblique ridge of the lower jaw, as far forward as the second bicuspid tooth and from the pterygo maxillary ligament. Its fibres converge to be inserted into the angle of the mouth.

The pterygo-maxillary ligament extends from the hamular process of the pterygoid plate to the posterior extremity of the molar ridge of the lower jaw. In front it gives origin to some of the fibres of the buccinator and behind to the superior constrictor of the pharynx.

External Pterygoid.

The external pterygoid muscle arises by a forked origin from the pterygoid ridge, the under surface of the outer face of the greater wing of the sphenoid, the external pterygoid plate, the tuberosity of the superior maxilla and the tuberosity of the palate bone. It passes backward and is inserted into the neck of the condyle of the lower jaw and into the interarticular fibro-cartilage.

Internal Pterygoid.

The internal pterygoid arises from the pterygoid fossa and passing downward, backward and outward is inserted into the inner surface of the ramus of the lower jaw as far as its angle.

The Muscles of the Back.

Those muscles of the back which are here described lie in three superimposed layers.

First Layer—Two Muscles.

Trapezius.

The trapezius arises from the superior curved line of the occipital bone, from the posterior occipital protuberance and from the spinous processes of all the dorsal and cervical vertebræ. The fibres converge outward, some ascending obliquely, some descending obliquely and some running horizontally to reach the insertion into the outer third of the clavicle, the acromion process and whole length of the spine of the scapula. Its insertion is the same as the origin of the deltoid.

Extending from the posterior occipital protuberance to the seventh cervical vertebræ, and attached to the intervening spinous processes, is a fibrous cord called ligamentum nuchæ; and it is in reality from this cord that the trapezius arises.

Action—According to the direction of the fibres which act it can draw the scapula directly backward, downward and backward or upward and backward.

Latissimus Dorsi.

The latissimus dorsi arises from the spinous processes of the lower four or six dorsal vertebræ, all the lumbar vertebræ and the spinous tubercles of the sacrum, from the posterior third of the crest of the ilium and by fleshy slips from the three or four lower ribs. The muscle is tendinous at its origin except that part arising from the ribs. As it passes upward and outward the fibres converge, become thicker and fleshy and passing over the lower angle of the scapula, wind around the teres major to be inserted along with it into the posterior bicipital ridge of the humerus. The tendon of the teres major is wider and extends further down on the humerus than that of the latissimus dorsi.

Action—It carries the humerus downward and backward, rotates it inward, is an inspiratory agent, and, when the humerus is fixed, as in climbing or using crutches, it moves the body forward.

Second Layer—Two Muscles.

Levator Anguli Scapulæ.

The levator anguli scapulæ arises by tendinous slips from the posterior tubercles of the transverse processes of the four upper cervical vertebræ. These slips unite to form the belly of the muscle which descends obliquely outward to be inserted into the posterior border of the scapula from the angle to the intersection of the spine with that border. Its name indicates its action.

Rhomboideus.

The rhomboideus arises from the spinous processes of the last cervical and four upper dorsal vertebræ, and passing downward and outward is inserted into the posterior border of the scapula as far as the inferior angle. Some make two muscles of this, calling the portion which arises from the cervical vertebra rhomboideus minor and that arising from the dorsal vertebræ rhomboideus major.

Action—It moves the scapula upward and backward.

Third Layer—Three Muscles.

Serratus Posticus Superior.

The serratus posticus superior has a tendinous origin from the spinous processes of the two lower cervical and two upper dorsal vertebræ. It

passes downward and outward and is inserted by fleshy serrations into the upper borders of the second, third, fourth and fifth ribs just beyond their angles.

Action—It is an inspiratory agent.

Serratus Posticus Inferior.

The serratus posticus inferior has a tendinous origin from the spinous processes of the last two dorsal and first two lumbar vertebræ. It passes upward and outward and is inserted by fleshy slips into the lower borders of the last four ribs.

Action—It is an expiratory agent.

Splenius.

The splenius arises from the spinous processes of the four lower cervical vertebræ and four or six upper dorsal vertebræ. It ascends and divides into two portions, one, known as the splenius capitis, is inserted into the occipital bone between its curved lines and into the mastoid portion and process of the temporal bone; the other, called splenius colli, is inserted into the posterior tubercles of the transverse processes of the three upper cervical vertebræ.

Action—It bends the head and upper part of the spine back and rotates the head toward its side.

The Muscles of the Thorax.

Triangularis Sterni.

The triangularis sterni is found on the posterior aspect of the front wall of the chest on either side of the sternum. It arises from the edge of the sternum and from the costal cartilages from the third to the sixth or seventh, and, passing upward and outward, is inserted into the second, third, fourth and fifth costal cartilages and corresponding ribs. Its insertion corresponds to that of its antagonist the serratus posticus superior.

Action—It is an expiratory agent.

Intercostal Muscles.

The interval between two ribs is occupied by two layers of muscular fibres which extend between the edges of adjacent ribs and are known as external and internal intercostal muscles.

The external intercostal muscles, eleven in number, have a direction downward and forward, like the external oblique of the abdomen, and extend from the tubercle of the ribs to the costal cartilages.

The internal intercostals, also eleven on each side, have a direction downward and backward and extend from the sternum to the angles of the ribs, corresponding in the direction of their fibres to the internal oblique of the abdomen.

Action—When acting from above they raise the ribs, being inspiratory agents. When acting from below they depress the ribs and are expiratory agents.

Muscles of the Neck.

Superficial Group—Two Muscles—

Platysma Myoides.

When the integument and superficial fascia have been removed from the front and side of the neck there is seen a thin pale broad muscle called the platysma myoides. It arises from the fascia covering the pectoralis major and deltoid muscles, and passes upward and inward over the clavicle to cover the side and front of the neck. Its innermost fibres are interlocked with the fibres of the opposite muscle along the upper part of the middle line of the neck; the others are inserted into the inferior maxilla, some passing over it to be lost on the side of the face and some continuing to the angle of the mouth; these last are joined by some accessory fibres which take their origin on the side of the face from the fascia covering the masseter muscle. These fibres have been considered as a separate muscle called risorius Santorini or laughing muscle.

Action—It is a depressor of the lower jaw. It can draw the angle of the mouth downward so as to produce a melancholy expression or carry it backward as in laughing.

Sterno-Cleido-Mastoid.

The sterno-cleido-mastoid is the second muscle in the superficial group and lies beneath the platysma between two layers of the deep cervical fascia. It is one of the most important muscles in the body and derives its name from its origin and part of its insertion.

It arises by a forked origin. One fork, a more or less rounded tendon, springs from the upper front part of the manubrium; the other, musculotendinous, arises from about the inner one-third or one-half of the clavicle. This origin is very variable. An interval, filled by fibrous tissue,

usually exists between the two heads. The muscle passes obliquely upward, backward and a little outward on the side of the neck and is inserted into the mastoid portion of the temporal bone and adjacent part of the superior curved line of the occipital. Between its two origins there is a fissure which extends upward for some distance.

Action—When both muscles act they bow the head forward; when one acts it draws the head to that side, turning the face somewhat to the opposite side.

Depressors of the Hyoid Bone—Four—

Sterno-Hyoid.

The sterno-hyoid derives its name from its attachments. It is ribbon-like in shape and vertical in direction. It arises from the posterior aspect of the manubrium sterni and perhaps from the inner extremity of the clavicle or sterno-clavicular ligament, and ascends the neck beside the middle line to be inserted into the hyoid bone.

Sterno-Thyroid.

Lying behind the sterno-hyoid and slightly broader than it, is another ribbon-like muscle called, from its attachments, sterno-thyroid. It arises from the posterior surface of the manubrium and possibly from the cartilage of the first rib, and, ascending beside the middle line is inserted into the oblique ridge on the ala of the thyroid cartilage. Below it is often traversed by a tendinous intersection as is the sterno-hyoid.

Thyro-Hyoid.

The thyro-hyoid is a short ribbon-like muscle which continues the course of the sterno-thyroid to the hyoid bone, and derives its name from its attachments. It arises from the oblique ridge on the ala of the thyroid cartilage and is inserted into the hyoid bone. Frequently some of the fibres of the sterno-thyroid are continued directly into this muscle.

Omo-Hyoid.

The omo-hyoid derives its name from its attachments. It is a double-bellied muscle passing with a curve across the side of the neck.

It arises from the upper border of the scapula, near the supra-scapular notch, and perhaps from the ligament stretched across the notch; and passes forward, inward and slightly upward until, beneath the sterno-

cleido mastoid, it becomes tendinous, its posterior belly ceasing. It then again becomes fleshy, forming the anterior belly, and passes nearly upward but with a slight inclination inward, to its insertion in the hyoid bone at the junction of its body and greater cornu. The central tendon is held down, so as to give the muscle its curve, by a loop of fascia which is said to pass to the cartilage of the first rib.

Action—The depressors of the hyoid bone, as the name indicates, draw the hyoid bone down. The sterno-thyroid draws down the larynx and the two omo-hyoids, acting together, draw the hyoid bone downward and backward. These muscles are sometimes spoken of as the infra-hyoid group.

Elevators of the Hyoid Bone—Five.

Digastric.

The digastric, as its name indicates, is a double-bellied muscle. It is round in shape, curved in direction and found at the upper part of the side of the neck. It arises fleshy from the digastric fossa of the temporal bone and passing downward and forward, becomes tendinous; the portion between its origin and central tendon being called the posterior belly. It then again becomes fleshy, forming the anterior belly, and passing forward and upward is inserted into the digastric fossa of the inferior maxilla. The central tendon pierces obliquely the belly of a small muscle which lies beside it called the stylo-hyoid, and, after emerging from it, plays through a loop of fascia which binds it down to the hyoid-bone.

Stylo-Hyoid.

The stylo-hyoid is a small muscle found lying beside the posterior belly of the digastric and deriving its name from its attachments. It arises from the outer side of the styloid process of the temporal bone, and passing downward and forward is inserted into the hyoid bone. Just before its insertion it is pierced by the central tendon of the digastric.

Mylo-Hyoid.

The mylo-hyoid is a broad, thin, triangular muscle which forms the floor of the mouth. It arises from the whole length of the mylo-hyoid ridge, and, passing nearly inward, with a slight inclination downward, the greater portion of the muscle meets its fellow of the opposite side on the middle line, forming a raphe, while some of its posterior fibres are inserted into the hyoid bone.

Genio-Hyoid.

The genio hyoid is a small muscle which slightly increases in size as it descends. It lies beneath the mylo-hyoid just beside the middle line. It arises from the inferior spina mentalis and passes backward and slightly downward to be inserted into the hyoid bone.

Genio-Hyo-Glossus.

The genio-hyo-glossus is a thin, radiating, fan-shaped muscle. It arises by a narrow tendinous origin from the superior spina mentalis and immediately radiates, fleshy, to be inserted into the under surface of the tongue from its base to near its apex, some of its lower fibres being inserted into the hyoid bone. This muscle lies close to the middle line beside its fellow.

Surgical Triangles of the Neck.

The side of the neck presents a quadrilateral surface which is bounded below by the clavicle, above by the body of the inferior maxilla and an imaginary horizontal line passing from its angle to the mastoid process of the temporal bone, in front by the middle line and behind by the anterior edge of the trapezius.

This space is subdivided by the sterno-mastoid into a great anterior and a great posterior triangle. The anterior triangle is bounded as follows: in front by the middle line, behind by the sterno-cleido-mastoid, above by the body of the lower jaw and the imaginary line. The base is above, the apex below. The posterior triangle has its base below, formed by the clavicle. It is bounded in front by the sterno-cleido-mastoid and behind by the anterior edge of the trapezius.

Each of these triangles is again subdivided into smaller ones. The anterior is divided into three:

1st. The inferior carotid triangle, or triangle of necessity, is bounded in front, by the median line; behind, by the anterior margin of the sterno-mastoid; above, by the anterior belly of the omo-hyoid. Its base is internal.

2d. The superior carotid triangle, or triangle of election, is bounded behind by the sterno-mastoid; below, by the anterior belly of the omo-hyoid; above, by the posterior belly of the digastric. Its base is external.

3d. *The digastric or submaxillary triangle* has its base formed by the lower jaw and the imaginary line and its sides formed, posteriorly, by the posterior belly of the digastric and stylo-hyoid, anteriorly, by the anterior belly of the digastric.

The great posterior triangle is subdivided into two:

1st. *The suboccipital triangle* has its base below. It is bounded in front by the sterno-mastoid; behind, by the anterior edge of the trapezius; below, by the posterior belly of the omo-hyoid.

2d. *The subclavian triangle* has its base below. It is bounded above by the posterior belly of the omo-hyoid; in front, by the sterno-mastoid; below, by the clavicle. It contains the subclavian artery and vein, hence its name, and the brachial plexus of nerves. In the posterior triangle the subdivisions are made by the posterior belly of the omo-hyoid; in the great anterior triangle by the anterior belly of the omo-hyoid, and the two bellies of the digastric.

The Scaleni Muscles.

The two scaleni muscles form part of a group called prævertebral, the rest of the group being unimportant; the only fact connected with them worthy of note being that they are interposed between the common carotid artery and the transverse processes of the cervical vertebræ.

The two scaleni muscles are distinguished as scalenus anticus and posticus. A small portion of the scalenus posticus is sometimes individualized as the scalenus medius. These muscles are of great importance owing to the fact that they occupy a position in the lower part of the side of the neck, and come into important relation with the subclavian artery and brachial plexus of nerves.

Scalenus Anticus.

The scalenus anticus, triangular in shape, arises from the anterior tubercles of the transverse processes of the third, fourth, fifth and sixth cervical vertebræ by tendinous slips, which, uniting as they descend, form the muscle. It is inserted by a narrow tendon into the upper surface of the first rib.

Scalenus Posticus.

The scalenus posticus arises from the posterior tubercles of the transverse process of all the cervical vertebræ except the first. It descends and divides into two portions, one of which is inserted into the first rib

between its tubercle and angle—and is the part sometimes called scalenus medius—while the other goes to the same point on the second rib.

Action—*When acting on the ribs they are inspiratory agents; acting* on the vertebral column they flex it.

Muscles of the Larynx.

The movements on each other of the separate cartilages which constitute the larynx are mainly effected by five small muscles called the intrinsic muscles of the larynx.

Crico-Thyroid.

The crico-thyroid, a triangular muscle, arises from the front of the cricoid cartilage and, passing upward, backward and outward, is inserted into the lower border of the thyroid cartilage from the median line in front to the inferior cornu.

Action—It stretches the vocal chords by drawing the thyroid cartilage forward and downward on the cricoid.

Posterior Crico-Arytenoid.

The posterior crico-arytenoid arises from the depression on the posterior aspect of the cricoid cartilage and, passing upward, outward and forward, is inserted into the outer angle of the base of the arytenoid.

Action—It separates the vocal chords by rotating the anterior angle of the base of the arytenoid outward, the vocal chord being attached to this angle.

Lateral Crico-Arytenoid.

The lateral crico-arytenoid arises from the side of the cricoid cartilage, and, passing upward, outward and backward, is inserted into the outer angle of the base of the arytenoid.

Action—It is the antagonist of the posterior crico-arytenoid; for, rotating the anterior angle of the base of the arytenoid inward, it approximates the vocal chords.

Arytenoid.

The arytenoid is a single muscle which arises from the concave posterior face of one arytenoid cartilage and passes transversely across the interval between the two to be inserted into the same part of the opposite cartilage.

Action—By drawing the arytenoid cartilages together it closes the glottis.

Thyro-Arytenoid.

The thyro-arytenoid arises from the receding angle of the thyroid cartilage just beside and external to the attachment of the vocal chords, and, passing backward, parallel with the vocal chord is inserted into the anterior angle of the base of the arytenoid cartilage.

Action—By approximating its points of attachment it relaxes the vocal chords and is said to throw them into vocalizing position, *i. e.*, the chord is thrown with its edge transverse to the length of the air-tube.

The Abdominal Muscles.

The anterior abdominal wall is formed chiefly by six flat, thin muscles, three on each side of the middle line, called the broad muscles of the abdomen. Besides these there are two other pairs, the pyramidales, small and insignificant, and the recti which are long and narrow. The abdominal wall consists of the following structures from without inward, viz: 1st, integument; 2d, two layers of superficial fascia with fatty tissue interposed; 3d, the external oblique muscle; 4th, the internal oblique; 5th, the transversalis; 6th, the transversalis fascia; 7th, the parietal layer of peritoneum. These muscles all terminate in tendinous fibres as they approach the median line; and, since there is no bone for them to seize, their fibres interlock, forming a white line extending from the ensiform cartilage to the symphysis pubis called the linea alba. The whole line is sunken below the surrounding surface and presents about its centre the umbilicus or navel. The sunken appearance is caused by the bulging of the recti, which lie on either side of it, the width of the linea alba corresponding to the interval between the recti.

External Oblique.

The external oblique of the abdomen derives its name from the downward and inward direction of its fibres and from its position, being external to another oblique muscle. It arises by eight fleshy, tooth-like processes or digitations from the anterior surface of the eight lower ribs. The upper five digitations interlock with similar processes of the serratus magnus, the lower three with the latissimus dorsi. From their origin the fibres pass downward and inward, the digitations gradually blending to form the belly of the muscle which, toward the front of the abdomen, terminates in a thin flat tendon, called an aponeurosis, which is inserted into the

linea alba from the sternum to the symphysis pubis. The posterior fibres pass almost vertically downward and are inserted into about the anterior one-half or two-thirds of the outer lip of the crest of the ilium; while the intermediate fibres are inserted into the anterior superior spinous process of the ilium and into the spine and pectineal line of the pubes. That portion of the aponeurosis which extends from the anterior superior spinous process of the ilium to the spine of the pubes is called Poupart's ligament. It is the lower border of the aponeurosis, is free between its points of attachment and folded slightly inward on itself. About an inch from the spine of the pubes Poupart's ligament sends downward some fibres which are inserted into the pectineal line of the pubis, forming Gimbernat's ligament, which is triangular in shape with its apex within and its base extending for about an inch outward.

At the lower, inner part of the aponeurosis is seen an opening, near the symphysis pubis, called the external abdominal ring. It is formed by a separation of the fibres of the aponeurosis, is triangular in shape and oblique in direction, its apex being upward and outward and its base downward and inward at the crest of the pubes. The edges of the aponeurosis which form the sides of the ring are called its pillars, internal and external, the external being inserted into the spine of the pubes and the internal interlocking with the internal pillar of the opposite side over the front of the pubes. For a short distance the apex of the ring is obscured by some curved fibres called intercolumnar fibres. The external abdominal ring transmits in the male the spermatic cord and in the female the round ligament.

SUMMARY.

Origin—By eight digitations from the external surface of the eight inferior ribs. Insertion—Into the whole length of the linea alba, the spine and pectineal line of the pubes, the anterior superior spinous process of the ilium and the anterior one-half or two-thirds of the crest of the ilium.

Internal Oblique.

The internal oblique muscle of the abdomen derives its name from the upward and inward obliquity of its fibres and from the position it occupies just beneath the external oblique. It arises by a thin tendinous membrane, called the fascia lumborum, from the spinous processes of the lumbar vertebræ, the anterior two-thirds of the middle lip of the crest of the ilium, and from the outer half of Poupart's ligament.

The fascia lumborum terminates in fleshy fibres on the side of the

abdomen, and those fibres springing from the crest of the ilium are also fleshy: these radiate somewhat, the general direction, however, being upward and inward, and are inserted, posteriorly, into the cartilages of the four lower ribs; while on the front of the abdomen the fibres become aponeurotic and are inserted into the whole length of the linea alba. The fleshy fibres which rise from the outer half of Poupart's ligament are blended with fibres of the transversalis which arise from the same part of the ligament. These blended fibres arch downward and inward and form, so long as they remain fleshy, the conjoined arch; but as they descend they become tendinous, forming the conjoined tendon which is inserted into the crest and pectineal line of the pubes. By reason of the arched direction of these fibres there is a short space between them above and Poupart's ligament below, their conjoined arch without and conjoined tendon within, where the wall of the abdomen has but one muscular element, viz: the aponeurosis of the external oblique. If an incision were made at this point we would pass through: 1st, the integument; 2d, two layers superficial fascia; 3d, the aponeurosis of the external oblique; 4th, transversalis fascia and the parietal layer of the peritoneum. The conjoined tendon descends just behind the external abdominal ring, so that at this point the wall is wanting in only one muscular element—the aponeurosis of the external oblique.

SUMMARY.

Origin—Outer one-half Pouparts ligament—Anterior two-thirds crest of ilium, spinous processes lumbar vertebræ.

Insertion—Lower border four lower costal cartilages, whole length linea alba, and, by conjoined tendon, into the crest and pectineal line of the pubes.

Transversalis.

The transversalis derives its name from the horizontal direction of its fibres. It lies just beneath the internal oblique and is the deepest of the three broad muscles of the abdomen. It arises by means of an aponeurosis from the transverse and spinous processes of the lumbar vertebræ, fleshy from the inner aspect of the cartilages of the six inferior ribs, interlocking with the diaphragm, fleshy from the anterior two-thirds of the inner lip of the crest of the ilium and fleshy from somewhat less than the outer half of Poupart's ligament. The posterior aponeurosis becomes fleshy on the side of the abdomen and these fibres, being reinforced by those which arise from the costal cartilages and crest of the ilium, pass

forward, become aponeurotic and are inserted into the whole length of the linea alba. The fibres which rise from Poupart's ligament blend with those of the internal oblique to form the conjoined arch and conjoined tendon which is inserted into the crest and pectineal line of the pubes.

SUMMARY.

Origin—Inner surface six lower costal cartilages, lumbar vertebræ, anterior two-thirds or three-fourths crest of ilium and a little less than the outer half of Poupart's ligament.

Insertion—Into the whole length of the linea alba and into the crest and pectineal line of the pubes.

Rectus.

The rectus abdominis derives its name from the straight course of its fibres. It lies on the front of the abdomen, beside the linea alba, surrounded by the aponeuroses of the three broad muscles of the abdomen. It is flat and ribbon-like in shape. It arises by a flat tendon from the front of the symphysis pubis and crest of the pubes; as it ascends it becomes fleshy and broader and terminates by three digitations which are inserted into the fifth, sixth and seventh cartilages just beside the sternum. In the upper half of its course the rectus presents three or four tendinous intersections which are called lineæ transversæ. Before the aponeurosis of the external oblique has been removed, the outer edge of the rectus presents a curved ridge called linea semilunaris. The rectus as it ascends is enclosed between the aponeurosis of the three broad muscles, and these form what is called its sheath. This sheath is complete in front for the whole length of the muscle, but behind is wanting for its lower fourth. It is thus formed: for the upper three-fourths of the rectus, or from a point half way between the umbilicus and the symphysis pubis upward to its insertion, the rectus has in front the aponeurosis of the external oblique and half the aponeurosis of the internal oblique; while for the same distance behind it has the aponeurosis of the transversalis and half of the aponeurosis of the internal oblique, the latter aponeurosis splitting, when it reaches the outer edge of the rectus, sending one layer in front and the other behind that muscle. Of course it also has behind it the transversalis fascia and the parietal layer of peritoneum separating it from the abdominal cavity. For its lower fourth, that is from the point midway between the umbilicus and symphysis pubis, all three aponeuroses pass in front of it; and behind it is separated from the abdominal cavity only by the parietal layer of the peritoneum and the

transversalis fascia. Where the sheath ends behind it is curved and is called the fold of Douglas.

SUMMARY.

Origin—crest of pubes and front of symphysis pubis.

Insertion—Into fifth, sixth and seventh costal çartilages.

Upper three-fourths of sheath formed in front by aponeurosis of external oblique and one-half aponeurosis of internal oblique.

Upper three-fourths of sheath formed behind by aponeurosis of transversalis and one-half aponeurosis of internal oblique.

Lower one-fourth of sheath has in front aponeurosis of the three muscles.

Pyramidalis.

The pyramidalis abdominis is small and derives its name from its pyramidal shape. It is found in the sheath of the rectus, in front of its lower portion, and is frequently absent on one or both sides. It arises from the front of the crest of the pubes and passes upward, tapering as it ascends to be inserted into the linea alba half way to the umbilicus.

Action—The abdominal muscles are agents of expulsion as in voiding the urine and fæces and in terminating labor. They are also agents of forced expiration, for when they contract they diminish the size of the abdominal cavity, forcing the abdominal viscera against the walls of that cavity and thus driving the diaphragm upward, while at the same time, by drawing down the ribs they in a measure diminish the size of the thorax.

Diaphragm.

1st. Definition and position—The diaphragm is the arched muscular septum between the two cavities of the trunk, presenting its upper convex surface as the floor of the thorax and its equally concave under surface as the roof of the abdomen.

2d. Relations—By its upper surface it supports the pleura on either side, containing the lungs, and the pericardium in the centre, containing the heart. Below it is covered by peritoneum and is in relation with the liver, spleen, stomach, pancreas and kidneys.

3d. Origin—In front it arises from the posterior surface of the sternum, on each side from the inner surface of the six lower ribs and from a ligamentum arcuatum externum and internum, behind from the front of the vertebral column by two crura.

4th. Its points of origin studied individually.

(*a*) Between that part which arises from the posterior surface of the sternum and that part on each side which arises from the adjacent ribs there usually exists a fissure for a short distance, the muscular structure here being wanting, and the aperture, which would otherwise exist, between the thoracic and abdominal cavities being closed by other structures.

(*b*) The origin from the inner surface of the ribs is by digitation which interlock with similar digitations of the transversalis abdominis.

(*c*) The ligamentum arcuatum externum arches across the quadratus lumborum muscle from the apex of the twelfth rib to the apex of the transverse process of the first or second lumbar vertebra, usually the second.

(*d*) The ligamentum arcuatum internum arches over the psoas magnus muscle from the apex of the transverse process of the first or second lumbar vertebra to be lost in the crus of the same side.

(*e*) The right crus arises tendinous from the front of the bodies of the second, third and fourth lumbar vertebræ.

(*f*) The left crus arises tendinous from the front of the bodies of the second and third lumbar vertebræ. It is smaller as well as shorter than the right.

5th. The appearances which it presents.

The muscular fibres of the diaphragm, as they are making for the centre, become tendinous. The central portion, therefore, is called the tendinous portion and is arranged like a clover leaf, presenting a central, a right and a left leaflet, the tendon is therefore called trefoil or central tendon.

The diaphragm is pierced by three large apertures which are for the transmission of the following structures, viz: 1st, descending aorta, vena azygos major, thoracic duct and sometimes the sympathetic nerve; 2d, the ascending vena cava; 3d, œsophagus and pneumogastric nerves.

The crura, as stated, arise tendinous from the front of the vertebral column, but as they ascend they become fleshy and leave a slight interval between them. Over the front of the twelfth dorsal vertebræ each crus gives off from its inner side a bundle of fibres which crosses obliquely to join the opposite crus, the one from the right crus being usually in front. This interchange of fibres is known as the decussation of the crura and it leaves between its commencement and the vertebral column an opening which is known as the aortic. This opening is over the front of the body of the twelfth dorsal vertebra, usually slightly to the left of

the middle line, but sometimes on it. The opening is *behind* the diaphragm and not through it.

The decussating fibres, after passing into the opposite crus, again separate from each other leaving an opening around which they again unite. This is the œsophageal opening and is situated above and to the left of the aortic opening, between it and the middle leaflet, and about opposite the tenth dorsal vertebra.

The opening for the inferior vena cava is to the right of the middle line, between the right and middle leaflets of the tendinous centre and about opposite the ninth dorsal vertebra.

6th. Action—The diaphragm is a respiratory muscle and an agent of expulsion. When it contracts, as it does eighteen to twenty times a minute, it descends, becoming less arched and thus increasing the size of the thorax while it decreases the size of the abdomen, though the latter is compensated by the bulging of the anterior abdominal walls; but should it be necessary to exert a straining effort, as in voiding the urine or fæces or in parturition, the muscles of the abdominal wall contract at the same time that the diaphragm does, so that the abdominal cavity is diminished in size from above downward as well as from before backward, and its viscera subjected to compression. When the diaphragm relaxes it again ascends, thus lessening the size of the thoracic cavity.

Quadratus Lumborum.

The quadratus lumborum is a quadrilateral muscle found in the posterior abdominal wall, in the lumbar region lying beside the vertebral column.

It arises from the last rib and descends, being attached by its inner edge to the transverse processes of the lumbar vertebræ, to be inserted into the ilium and the ilio-lumbar ligament.

Action—It draws the vertebral column to one side, and acts as an expiratory agent by drawing down the last rib.

Muscles of the Upper Extremity.

Anterior Thoracic Region—

PECTORALIS MAJOR. PECTORALIS MINOR. SUBCLAVIUS.

Pectoralis Major.

The pectoralis major derives its name from its position on the front of the chest, and from the fact that there is another muscle smaller than it

in the same region. It is coarse in structure, triangular in shape with its base within and apex without. It arises fleshy from the sternal two-thirds of the clavicle, from the whole length of the front of the sternum and from the cartilages of five ribs, *i. e.* all of true ribs except the first and seventh (this origin being by fibres which reinforce the muscle as it passes over the ribs) and from the aponeurosis of the external oblique muscle of the abdomen.

The fibres converge as they pass outward. Those from the clavicle pass nearly vertically downward, those from the lower part of the sternum and the aponeurosis of the external oblique pass obliquely upward and outward and the intermediate fibres pass horizontally outward. They all terminate in a folded tendon which is inserted into the anterior bicipital ridge of the humerus. As the fibres are approaching their termination some fold over the others, those from the lower portion of the origin of the muscle passing behind and forming the upper part of the tendon, those from the clavicle passing in front and forming the lower part of the tendon.

Action—It draws the humerus across the chest.

SUMMARY.

Origin—Sternal two-thirds clavicle, whole length front of sternum, cartilages of true ribs except first and seventh, aponeurosis of external oblique.

Insertion—By folded tendon into anterior bicipital ridge of the humerus.

Pectoralis Minor.

The pectoralis minor derives its name from its position on the front of the chest, and from the fact that there is another pectoral muscle of larger size. It is found beneath the pectoralis major, is small in size, oblique in direction and triangular in shape. It arises from the front of the third, fourth and fifth ribs, passes upward and outward, fleshy, narrows to a tendon and is inserted into the coracoid process of the scapula.

Action—Rotates the scapula on the thorax and, when the scapula is fixed, aids in expanding the chest.

Subclavius.

The subclavius derives its name from its position just beneath the clavicle. It is a small round muscle which arises from the cartilage, and

possibly the adjacent osseous portion, of the first rib by a tendon, it passes horizontally outward, becomes fleshy, and almost immediately after it ceases to rise, begins to be inserted, its belly being extremely short, into the whole length of the groove on the under surface of the clavicle. This groove occupies about the middle one-third of the clavicle.

Action—It draws the clavicle downward.

Thoracic Surgical Triangle.

Lying just beneath the subclavius, which is sometimes given as its upper limit, is a triangular space of surgical importance. It is bounded above by the clavicle, below by the upper edge of the pectoralis minor; its apex is without and is crossed by the axillary vessels and nerves; its base is within and is formed by an imaginary line drawn from the inner extremity of the clavicle to the commencement of the origin of the pectoralis minor.

Lateral Thoracic Region.

Serratus Magnus.

The serratus magnus is a large thin muscle found upon the side of the chest wall. It derives its name from its extensive origin by means of digitations or serrations.

It arises by nine digitations from the outer surface of the eight upper ribs, the lower five interlocking with serrations of the external oblique, and two arising from the second rib. Its origin is fleshy, and it continues its course, fleshy, outward and backward over the side of the chest, to be inserted into the whole length of the anterior edge of the posterior border of the scapula.

Action—It moves the scapula on the thorax and, when the scapula is fixed, raises the ribs.

Acromial Region.

Deltoid.

The deltoid is a large, coarse, triangular muscle forming the bulge of the shoulder and deriving its name from its resemblance to the Greek letter Δ (delta). It arises from the outer one-third of the clavicle, from the acromion process and whole length of the spine of the scapula. Passing downward it converges to a short tendon which is inserted into the deltoid impression about half way down the outer surface of the shaft of the humerus.

Action—It raises the humerus, *i. e.*, abducts it, and by its posterior fibres can carry it backward, or by its anterior fibres forward.

Scapular Group.

SUBSCAPULARIS.

SUPRA-SPINATUS.	TERES MAJOR.
INFRA SPINATUS.	TERES MINOR.

Subscapularis.

The subscapularis is a coarse, flat muscle, which occupies the subscapular fossa. It arises from the whole of the fossa with the following exceptions: *i. e.*, a small portion near the superior and inferior angles, a narrow strip along the posterior border where the serratus magnus is inserted and the outer one-third of the fossa. It also gets some fibres from the fascia which invests it, and from the septa sent down by this fascia to seize ridges on the venter of the scapula. The muscle passes upward and outward toward the neck of the scapula, narrows to a tendon as it approaches the humerus, and is inserted into the lesser tuberosity of the humerus and into the bone for an inch below.

Action—It is an inward rotator of the humerus.

Supra-Spinatus.

The supra-spinatus lies in the supra-spinous fossa on the dorsum of the scapula. It arises from the whole of the fossa, except its outer third, and form the investing fascia of the muscle and, passing forward beneath the acromion process, narrows to a tendon which is inserted into the highest of the three muscular impressions on the great tuberosity of the humerus. As the spine forms a part of this and the infra-spinous fossæ it is unnecessary to mention it separately in describing the origin of the two muscles.

Action—It aids the deltoid in raising or abducting the humerus and is an outward rotator.

Infra-Spinatus.

The infra-spinatus arises from the whole of the infra-spinous fossa, except its outer third, and from the investing fascia covering the muscle. Passing upward and outward it is inserted into the middle of the three muscular impressions on the great tuberosity of the humerus.

Action—It is an outward rotator of the humerus.

Teres Minor.

The teres minor lies along the lower edge of the infra-spinatus, from which it is separated by a septum of fascia. It arises from the upper two-thirds of the axillary border of the scapula and ascends to terminate in a tendon which is inserted into the lowest of the three muscular impressions on the great tuberosity of the humerus.

Action—It is an outward rotator of the humerus.

Teres Major.

The teres major lies just below the teres minor from which, after its origin, it is separated by a widening interval. It arises from the lower one-third of the axillary border of the scapula and from a small portion of the dorsum of the scapula near its inferior angle and, passing upward and outward, is inserted by a flat tendon into the posterior bicipital ridge of the humerus.

Action—It draws the humerus downward and backward.

Surgical Triangle.

Between the two teres muscles there is a triangular space whose base is the humerus and whose sides are formed as follows: above, by the lower border of the teres minor; below, by the upper border of the teres major. This space is subdivided by the long head of the triceps, into a quadrilateral and triangular space. The boundaries of the quadrilateral space are as follows: posteriorly the long head of the triceps; anteriorly the humerus; inferiorly the teres major; superiorly the teres minor. The small triangular space is bounded in front by the long head of the triceps, which forms its base: above by the teres minor; below by the teres major.

Muscles of the Humerus or Arm.

BICEPS FLEXOR.	BRACHIALIS ANTICUS.
CORACO BRACHIALIS.	TRICEPS.

When the skin and two layers of superficial fascia have been removed from the arm (that part of the upper extremity which extends between the shoulder and the elbow) there is exposed a strong, fibrous membrane, called the deep fascia, which forms a complete investment for the limb, binding down the muscles and sending a septum from its inner surface to

the internal and external condyloid ridges, to separate the muscles on the front from that on the back of the humerus. They are known respectively as internal and external intermuscular septa.

The muscles of the arm are divided into two groups, anterior and posterior.

Anterior Humeral Group.

Biceps Flexor.

The biceps, as its name indicates, has a forked origin arising by two tendons, one, its short head, from the coracoid process of the scapula in common with the coraco-brachialis; the other, the long head, from the upper margin of the glenoid cavity of the scapula, where it blends with the glenoid ligament. The belly of the muscle, formed from these two origins, descends on the front of the arm to the elbow where it terminates in a tendon which, after giving off a slip from its inner side to the deep fascia of the forearm, is inserted into the posterior part of the bicipital tuberosity of the radius.

Action—It flexes the forearm, *i. e.*, draws it forward and upward on the arm, and is also a supinator of the forearm.

Coraco-Brachialis.

The coraco-brachialis is a short muscle which rises in common with the short head of the biceps from the coracoid process of the scapula, descends on the inner side of the biceps, to which it is adherent for a short distance, and is inserted into a vertical ridge about the middle of the inner surface of the shaft of the humerus.

Action—It is a flexor of the arm and can also carry the arm inward across the chest.

Brachialis Anticus.

The brachialis anticus is the fleshy mass which lies beneath the biceps on the lower part of the front of the arm. It arises by two digitations which embrace the deltoid "V" and from the front of the shaft of the humerus from that point to within an inch of the elbow, from the whole of the internal intermuscular septum and from the external intermuscular septum for a few inches. It passes over the elbow and is inserted into the front of the coronoid process of the ulna. The muscle is cut off from part of the external intermuscular septum by the origin of the supinator longus and the extensor carpi radialis longior.

Action—It is a flexor of the forearm.

Posterior Humeral Group.

Triceps Extensor.

The triceps is the large fleshy mass which covers nearly the whole of the posterior aspect of the humerus, and is the only muscle found there. It arises by three heads, known as long (or middle), short (or internal) and external, which is intermediate in length. The long head arises from the upper inch of the axillary border of the scapula, while the other two arise from the whole of the posterior aspect of the shaft of the humerus, from the insertion of the teres major internally and the teres minor externally, downward to the condyles, and from the external and internal intermuscular septa. It is inserted into the depressed surface on the olecranon process of the ulna. The origin may be stated by starting at the insertion and tracing the muscle upward, when the internal head will be seen to arise from the inner half of the posterior aspect of the humerus and the internal intermuscular septum, the outer head from the outer half of the posterior aspect of the humerus and external intermuscular septum and the long head from the upper inch of the axillary border of the scapula, the three uniting about the middle of the arm to form the belly of the muscle.

Action—It extends the forearm on the arm.

Muscles of the Forearm.

The muscles of the forearm are divided into those on the front and those on the back of the forearm. The deep fascia of the arm is continued over the elbow and invests the forearm, giving off from its inner surface septa, known as intermuscular or dividing septa, which separate the muscles from each other.

Muscles on the Front of the Forearm.

First Layer.	*Second Layer.*
PRONATOR RADII TERES.	FLEXOR LONGUS POLLICIS.
FLEXOR CARPI RADIALIS.	FLEXOR PROFUNDUS DIGITORUM.
FLEXOR CARPI ULNARIS.	PRONATOR QUADRATUS.
PALMARIS LONGUS.	
FLEXOR SUBLIMIS DIGITORUM.	

The muscles on the front of the forearm have for their action the production of the following movements:

1st. Pronation, or revolution of the radius around the ulna, thus turning the palm of the hand downward or rather backward—for the anatomical position exists, when the palm of the hand looks forward.

2d. Flexion of the hand at the wrist, *i. e.*, bringing the hand forward on the forearm.

3d. Flexion of the fingers on the hand or at the inter-phalangeal joints.

4th. Flexion of the thumb on the hand.

To produce pronation there are two muscles, the round pronator (pronator radii teres) and the square (pronator quaratus). To produce flexion at the wrist joint there are three muscles, two known as flexors of the carpus while the third has the unfortunate name of palmaris longus. The two flexors are distinguished as radial and ulnar from the bones near which they lie instead of being named internal and external as they should be. To produce flexion of the fingers there are two muscles called superficial and deep since the one lies on the other. Each muscle sends a tendon to each of the four fingers. To produce flexion of the thumb there is one muscle of the forearm, called the long flexor of the thumb to distinguish it from the short flexor which is found in the hand.

The muscles on the front of the forearm seem to have a preference, as a bony origin, for the internal condyle of the humerus; many also take origin from the deep fascia, which adheres to them closely for about three inches below the elbow. No muscle, of course, can arise from this fascia which is not superficial in the upper part of the forearm. Another point of origin for some of them is the intermuscular or dividing septa. As so many muscles spring from these sources, we speak of them as having a common origin which, for muscles on the front of the forearm, is thus stated, viz: internal condyle, intermuscular septa and deep fascia.

The muscles of the forearm are divided into two layers.

First, or Superficial Layer.

Pronator Radii Teres.

The pronator radii teres has a double origin, from the common origin and from the coronoid process of the ulna. It is inserted into the middle third of the oblique line of the radius.

Flexor Carpi Radialis.

The flexor carpi radialis arises from the common origin and is inserted into the base of the metacarpal bone of the index finger. Its tendon grooves the trapezium.

Palmaris Longus.

The palmaris longus arises from the common origin, and is inserted into the palmar fascia, and anterior annular ligament.

Flexor Carpi Ulnaris.

The flexor carpi ulnaris arises from the common origin, from the inner side of the olecranon and by a strong aponeurosis from the upper two-thirds of the posterior border of the ulna. It is inserted into the base of the metacarpal bone of the little finger, enclosing the pisiform as a sesamoid bone.

Flexor Sublimis Digitorum.

The flexor sublimis digitorum has five points of origin—1st, internal lateral ligament of the elbow; 2d, coronoid process of the ulna; 3d, the oblique line of the radius for several inches, and from the common origin. This really makes six points, but the first is common to all the foregoing muscles. It descends beneath the superficial layer of muscles, and divides into four tendons at the lower part of the forearm, which enter the hand and proceed, one to each finger, to be inserted into the side of the shaft of the second phalanx. At the base of the fingers it splits to allow the passage of the tendon of the deep flexor, unites and then again splits to be inserted into the side of the second phalanx.

Second Layer.

Flexor Profundus Digitorum.

The flexor profundus digitorum lies just beneath the sublimis and to the ulnar side of the next muscle. It arises from the upper two-thirds of the ulna and from the ulnar part of the interosseeus membrane, divides into four tendons, which enter the palm of the hand and, separating, run one to each of the fingers, pierce the tendon of the superficial flexor at the base of the fingers, and are inserted into the base of the last phalanx.

Flexor Longus Pollicis.

The flexor longus pollicis lies to the outer side of the preceding muscle. It arises from about the middle two-fourths of the front of the radius and from the radial part of the interosseous membrane, and is inserted into the base of the last phalanx of the thumb.

Pronator Quadratus.

The pronator quadratus, as its name imports, is quadrilateral. Occupying the lower fourth of the forearm, it prevents the origin of the two preceding muscles for that distance. It arises from the inner side of the ulna, receiving a few fibres from its front as it passes over it, and is inserted into the front of the radius as far as its outer side.

Interosseous Membrane.

The interosseous membrane, mentioned above, is a strong fibrous membrane stretched between the two bones. It economizes weight, while it furnishes as stable an origin for muscles as does bone.

Posterior Region.

The muscles upon the back of the forearm also have a common origin, viz: external condyle of humerus, investing fascia and intermuscular septa.

They are divided into three groups, each containing four muscles, called radial, superficial and deep groups. These muscles, are either extensors or supinators, acting in opposition to those on the front of the forearm.

Radial Group.

SUPINATOR LONGUS. EXTENSOR CARPI RADIALIS LONGIOR.
EXTENSOR CARPI RADIALIS BREVIOR. SUPINATOR BREVIS.

Supinator Longus.

The supinator longus derives its name from the facts that it is a supinator of the arm and that there is another supinator called brevis.

It arises from the upper two-thirds of the external condyloid ridge and from the external intermuscular septum, and, after descending about two-

thirds of its course, terminates in a tendon which is inserted into the base of the styloid process of the radius.

Extensor Carpi Radialis Longior.

The extensor carpi radialis longior derives its name from the action of the muscle and from the fact that there is another radial extensor which is shorter. It arises from the lower one third of external condyloid ridge and from the external intermuscular septum, and descends to be inserted by its tendon into the base of the metacarpal bone of the index finger.

Extensor Carpi Radialis Brevior.

The extensor carpi radialis brevior, deriving its name from the facts stated with the preceding muscle, arises from the common origin and is inserted into the base of the metacarpal bone of the middle finger.

Supinator Brevis.

The supinator brevis arises from the external condyle of the humerus, the external lateral and orbicular ligaments and from the triangular depressed surface beneath the lesser sigmoid cavity of the ulna. It winds around the radius and is inserted into the upper third of its oblique ridge.

Back of Forearm—Superficial Group.

EXTENSOR COMMUNIS DIGITORUM.
EXTENSOR MINIMI DIGITI.
EXTENSOR CARPI ULNARIS.
ANCONEUS.

Extensor Communis Digitorum.

The extensor communis digitorum derives its name from its action as the extensor common to the four fingers. It arises from the common origin and, descending, divides into four tendons, which are each inserted into the four lesser fingers along the whole length of the back of each.

Extensor Minimi Digiti.

The extensor minimi digiti is an offshoot of the common extensor and, as its name indicates, has for its function the extension of the little finger. It arises from the common origin and is inserted into the whole length of the back of the little fingers along with the slip furnished that finger by the common extensor.

Extensor Carpi Ulnaris.

The extensor carpi ulnaris derives its name from its action as an extensor of the hand and from its situation on the ulnar side of the forearm. It arises from the common origin and from the middle third of the posterior border of the ulna, and is inserted into the base of the metacarpal bone of the little finger.

Anconeus.

The anconeus is a small triangular muscle which arises by its apex from the external condyle of the humerus, and is inserted by its base into the olecranon process and triangular surface at the upper extremity of the ulna. It is really an offshoot of the triceps extensor, and its action is to aid that muscle in extending the forearm on the arm.

Deep Group.

The four muscles of this group lie beneath those of the superficial group, and all arise from the interosseous membrane as one attachment. As indicated by their names, they are all extensors, three being appropriated by the thumb and one by the index finger.

Extensor Ossis Metacarpi Pollicis.

The extensor ossis metacarpi pollicis arises from the the radius, ulna and interosseous membrane and is inserted into the base of the metacarpal bone of the thumb.

Extensor Primi Internodii Pollicis.

The extensor primi internodii pollicis arises from the radius and interosseous membrane and is inserted into the base of the first phalanx of the thumb.

Extensor Secundi Internodii Pollicis.

The extensor secundi internodii pollicis arises from the ulna and interosseous membrane and is inserted into the base of the first phalanx of the thumb.

Extensor Indicis.

The extensor indicis arises from the ulna and interosseous membrane and is inserted into the whole length of the back of the index finger, blending with the tendon furnished that finger by the common extensor.

Action—All of these muscles are extensors, their names indicating the bone on which they act.

Posterior Annular Ligament.

This is an oblique fibrous band passing downward and inward across the back of the wrist from the lower extremity and styloid process of the radius to the cuneiform and pisiform bones. It holds the extensor tendons down on the bones and gives off from its deep face septa which, being attached to bone, form six compartments, through which the tendons thus separated play.

The Muscles of the Hand.

The central portion of the palm of the hand is depressed below the level of a prominence on either side, one, extending from the base of the little finger toward the wrist, called the hypothenar eminence, and the other, considerably more prominent, extending upward from the base of the first phalanx of the thumb toward the wrist, called the thenar eminence.

When the skin has been removed a thick layer of fatty tissue is exposed, which serves as a protection for the vessels and nerves in grasping with the hand; and beneath this is a strong fascia called the palmar fascia. It has a thick central portion and two thinner lateral portions which cover the muscles forming the thenar and hypothenar eminences. Tracing this fascia to the wrist, it is found to be continuous with a strong fibrous band which extends across the wrist from one side to the other, binding down the tendons which pass beneath it, known as the anterior annular ligament.

The muscles of the hand consist of two groups, the thenar and hypothenar groups, and four small muscles found in the depressed portion of the hand, called lumbricales.

Thenar Group—Four Muscles.

The muscles of the thenar group are appropriated to the thumb, the movements of which are as follows: (*a*) Abduction, or movement of the thumb outward from the index finger. (*b*) Adduction, a movement in the opposite direction. (*d*) Flexion, in which the thumb is put in contact with the palp of any of the fingers. This is effected by putting in motion the metacarpal bone of the thumb by a muscle called opponens.

(*c*) Extension, movement in the opposite direction effected by muscles on the back of the forearm, which have been described.

Abductor Pollicis.

The abductor pollicis arises from the trapezium bone and anterior annular ligament, and is inserted into the outer side of the base of the first phalanx of the thumb.

Flexor Ossis Metacarpi Pollicis.

The flexor of the metacarpal bone of the thumb, or the opponens pollicis, arises from the trapezeium bone and anterior annular ligament, and is inserted into the whole length of the radial border of the metacarpal bone of the thumb.

Flexor Brevis Pollicis.

The flexor brevis pollicis consists of two parts, one of which, the superficial portion, arises from the trapezium bone and annular ligament, and the other, or deep portion, from the trapezoid, os magnum and base of the metacarpal bone of the middle finger. It is inserted into both sides of the base of the first phalanx of the thumb, its tendons of insertion having sesamoid bones in them.

Adductor Pollicis.

The adductor pollicis is a flat triangular muscle which arises by its base from the whole length of the front of the metacarpal bone of the middle finger. It is inserted into the inner side of the base of the first phalanx of the thumb.

Hypothenar Group.

Palmaris Brevis.

The palmaris brevis is a small pale muscle lying just beneath the skin of the palm. It arises from the palmar fascia and the anterior annular ligament, and passing inward, about an inch wide, is inserted into the skin on the inner border of the hand.

Abductor Minimi Digiti.

The abductor minimi digiti arises from the pisiform bone and is inserted into the inner side of the base of the first phalanx of the little finger.

Action—It is an abductor of the little finger, *i. e.*, draws the little finger inward away from the ring finger.

Flexor Brevis Minimi Digiti.

The flexor brevis minimi digiti arises from the unciform process of the unciform bone and the anterior annular ligament, and is inserted into the base of the first phalanx of the little finger.

Action—It is a flexor of the little finger.

Adductor Ossis Metacarpi Minimi Digiti.

The adductor ossis metacarpi minimi digiti arises from the unciform process of the unciform bone and the anterior annular ligament, and is inserted into the whole length of the metacarpal bone of the little finger.

Action—It draws the metacarpal bone of the little finger outward and forward, carrying the little finger towards the thumb.

Flexor Tendons of the Fingers.

It has been seen that the tendons of the flexor sublimis digitorum split at the base of the fingers to allow the passage of the tendons of the flexor profundus, unite and again split to be inserted into the sides of the shaft of the second phalanx of each finger. Before its insertion each tendon gives off thread-like prolongations, called vincula accessoria, which are inserted into the sides of the bones; and both tendons are bound down to the bones by transverse bands of ligamentous fibres called the thecæ.

Muscles of the Lower Extremity.

The muscles of the lower extremity are divided into those of the hip, thigh, leg and foot. The hip is called the gluteal region.

Gluteal Region.

As in the upper extremity, the muscles are here covered by an investing fascia, which is much thicker and stronger than in the former situation, known in the thigh as the fascia lata or vagina femoris.

The muscles of the gluteal region, nine in number, are arranged in three layers, each of which has a muscle called gluteus.

First Layer.

Gluteus Maximus.

The gluteus maximus is a quadrilateral muscle, the largest and coarsest in the body, and forms the bulge of the buttock. It arises from the posterior fifth of the crest of the ilium, from the dorsum ilii between the superior curved line and the crest, from the posterior surface of the sacrum and cocyx and from the greater sacro-sciatic ligament. It passes obliquely downward and outward to be inserted into the line leading from the trochanter major to the linea aspera and into the fascia lata.

Action—It is an abductor and outward rotator of the thigh, a tensor of the fascia lata and steadies the pelvis on the femur.

Second Layer.

GLUTEUS MEDIUS.	GEMELLUS INFERIOR.
PYRIFORMIS.	OBTURATOR INTERNUS.
GEMELLUS SUPERIOR.	QUADRATUS FEMORIS.

Gluteus Medius.

The gluteus medius is partially covered by the gluteus maximus. It arises from the anterior four-fifths of the crest of the ilium, from the dorsum ilii between the middle curved line and the crest and from the investing fascia, which covers its outer front part. It is inserted into the outer part of the trochanter major. On its outer edge the muscle is continuous with the gluteus maximus.

Action—It is an abductor and outward rotator of the thigh, steadies the pelvis on the femur and aids in carrying the lower extremity forward in progression.

Pyriformis.

The pyriformis is a pear-shaped muscle. It arises within the pelvis by three fleshy slips interposed between the anterior sacral foramina from the first to the fourth and from the adjoining part of the ilium. It escapes from the pelvis through the greater sacro-sciatic foramen, passes downward and outward, and is inserted into the posterior border of the upper extremity of the trochanter major, or into the digital pit.

Action—It is an external rotator of the thigh.

The Gemelli.

The gemelli are a pair of small muscles lying one above and the other below the tendon of the obturator internus.

The gemullus superior arises from the spine of the ischium, runs horizontally outward and is inserted into the digital pit of the trochanter major.

The gemellus inferior arises from the tuberosity of the ischium, passes horizontally outward and is inserted into the digital fossa.

Action—Both are outward rotators of the thigh.

Obturator Internus.

The obturator internus arises within the pelvis from the inner surface of the obturator membrane, from the margin of the obturator foramen and from the inclined plane of the ischium. Its course is downward and slightly backward until, becoming tendinous, it escapes from the pelvis through the lesser sacro-sciatic foramen, and passing horizontally outward, its tendon winding around the posterior border of the ischium just below the spine, it is inserted into the digital fossa of the trochanter major.

Action—It is an outward rotator of the thigh.

Quadratus Femoris.

The quadratus femoris, as its name indicates, is a square muscle which lies below the tendon of the obturator internus. It arises from the tuberosity of the ischium, and is inserted into the posterior intertrochanteric line.

Action—It is an outward rotator of the thigh.

Third Layer.

GLUTEUS MINIMUS. OBTURATOR EXTERNUS.

Gluteus Minimus.

The gluteus minimus lies beneath the gluteus medius and maximus. It is a triangular radiated muscle which arises from the dorsum ilii between the middle and inferior curved lines. It passes down, narrowing

as it descends, and is inserted into the anterior border of the trochanter major. In front it is continuous with the gluteus medius.

Action—It is an abductor and *inward* rotator of the thigh. Acting from below it steadies the pelvis on the femur.

Obturator Externus.

The obturator externus arises from the inner two-thirds of the outer surface of the obturator foramen. It narrows to a tendon, which, passing outward behind the neck of the femur, is inserted into the digital pit of the trochanter major. It lies on the capsular ligament of the hip-joint.

Action—It is an external rotator of the thigh.

Femoral Region.

The muscles of the thigh are arranged in four groups, viz: posterior, superficial, anterior and internal femoral groups. Investing the thigh, just beneath the skin and superficial fascia, is a strong, thick, fibrous membrane descending to the knee it invests the joint and passes on to become the investing fascia of the leg. From the hip to the knee it is known by three names, investing fascia of the thigh, vagina femoris, or, generally, fascia lata. It not only forms a firm resisting covering for the muscles, but sends in septa between the groups. Two of these septa attached to the lips of the linea aspera, are known respectively as the external and internal intermuscular septa. The fascia lata consists of layers between which are found three muscles of the thigh forming the superficial femoral group.

The posterior femoral muscles have a common origin from the tuber ischii and are all three flexors of the leg, *i. e.*, they raise the leg backward on the thigh.

Posterior Femoral Region.

BICEPS FLEXOR CRURIS. SEMITENDINOSUS.
SEMIMEMBRANOSUS.

Biceps Flexor Cruris.

The biceps, as its name imports, arises by two heads. The long head springs in common with the semitendinosus from the tuberosity of the

ischium and descends adherent to the semitendinosus for several inches. It then accompanies the semitendinosus, but no longer adherent to it, to the lower third of the thigh; is joined by the short head which arises from the whole length of the outer lip of the body of the linea aspera and from the external intermuscular septum. The muscle thus formed after descending to the lower third of the femur in contact with the semitendinosus, leaves that muscle and makes for the outer side of the knee joint, where it is inserted chiefly into the head of the fibula, but sends some fibres to the outer tuberosity of the tibia and to the fascia of the leg.

Semitendinosus.

The semitendinosus arises in common with the long head of the biceps, adheres to it for several inches and then descends in contact with it to the lower third of the thigh where it leaves the biceps and passes to the inner aspect of the knee-joint where it is inserted into the inner surface of the shaft of the tibia, below the inner tuberosity sending a slip to the fascia of the leg. This is known as the "goose foot" insertion. It is made up of three muscles, viz: semitendinous, sortorius and gracilis.

Semimembranosus.

The semimembranosus arises from the tuberosity of the ischium just in front of the preceding muscles and descends in company with them to the lower third of the femur whence it accompanies the semitendinous to the inner side of the knee-joint and receives a three-fold insertion, viz: into the horizontal groove on the inner tuberosity of the tibia, into the popliteal fascia and into the posterior ligament of the knee-joint.

These three muscles are spoken of as the hamstring muscles, the biceps being the outer, the semimembranous and semitendinosus being the inner.

Popliteal Space.

On the posterior aspect of the knee-joint there is a surgical space known as the popliteal. It is diamond-shaped and has four angles. It is formed, superiorly by the divergence of the hamstring muscles and inferiorly by the covergence of the two heads of the gastrocnemius and its boundaries are as follows: its outer sides are formed above by the biceps, below by the outer head of the gastrocnemius; its inner, above by the internal hamstring muscles, below by the inner head of the gastrocnemius. Its superior angle is formed by the divergence of the pos-

terior femoral muscles; the inferior by the convergence of the heads of the gastrocnemius; the internal lateral by the intersection of the semitendinous and semimembranous and the inner head of the gastrocnemius; the external lateral by the intersection of the biceps and external head of the gastrocnemius.

The floor of the space is formed by three parts. The upper part is the posterior aspect of the lower third of the femur; the middle portion is the posterior ligament of the knee-joint; the lower part is the popliteal fascia covering the popliteus muscle and corresponds to the upper fifth of the tibia.

The space is important from the fact that passing through it from above downward are (*a*) a large artery, (*b*) a little more superficial a large vein and (*c*) most superficial of all, a large nerve, all called popliteal.

Superficial Femoral Group.

TENSOR VAGINÆ FEMORIS. GRACILIS. SARTORIUS.

Tensor Vaginæ Femoris.

The tensor vaginæ femoris is a short flat muscle found lying on the outer aspect of the thigh between the two layers of the fascia lata. It arises from the outer lip of the crest of the ilium near the anterior superior spinous process, descends with an inclination backward and is inserted into the fascia lata about one-fourth down the thigh.

Action—It is a tensor of the fascia lata and aids in rotating the limb inward.

Sartorius.

The sartorius is the longest muscle in the body. It arises from the anterior superior spinous process of the ilium and half the notch below, passes obliquely downward and inward across the upper third of the thigh, descends vertically behind the internal condyle of the femur and then turns obliquely forward to be inserted into the upper inner face of the tibia below the internal tuberosity, sending a slip to the fascia of the leg. It forms one of the elements of the "goose foot" insertion, the other two being the semitendinous and gracilis. The sartorius is the most superficial at the insertion, then the gracilis and the semitendinosus is the deepest.

Action—It flexes the thigh on the pelvis, the leg on the thigh and carries it inward across its fellow.

Gracilis.

The gracilis arises by a thin broad aponeurosis from the edge of the symphysis pubis and from the margin of the ischio-pubic-ramus. It soon becomes fleshy and passes down the inner aspect of the thigh to be inserted into the upper inner part of the tibia, below the inner tuberosity, sending a slip to the fascia of the leg, *i. e.*, it is an element of the "goose foot" insertion.

Action—It flexes the leg on the thigh and aids in adducting the thigh.

Anterior Femoral Region.

PSOAS MAGNUS.	VASTUS EXTERNUS.
ILIACUS INTERNUS.	VASTUS INTERNUS.

Rectus Femoris.

The muscles in this region are usually described as five but can very readily be considered as two, viz: Biceps flexor femoris, consisting of psoas magnus and iliacus internus and the triceps extensor cruris consisting of rectus femoris, vastus internus and vastus externus. The last three are inserted by a common tendon, called the ligamentum patellæ, into the anterior tubercle of the tibia, their action being transmitted through the patella to which they are attached.

As might be inferred from their action they all arise from some point perpendicular to their insertion.

Psoas Magnus.

The psoas magnus is a long spindle shaped muscle lying beside the vertebral column and descending into the thigh. It arises from the bodies and bases of the transverse processes of the last dorsal, and all the lumbar vertebræ; from the intervertebral disks between them and from tendinous arches attached to the bodies of the vertebræ, extending from the upper lipped edge to the similar lower edge of each vertebra, thus leaving between it and the central constricted portion of the vertebra an interval through which vessels and nerves pass. The muscle descends beside the vertebral column to the pelvis and, as it pass beneath Poupart's ligament, is joined by the iliacus internus and their blended tendon is inserted into the trochanter minor of the femur and the bone for an inch below.

Action—It is a flexor of the thigh on the pelvis.

Iliacus Internus.

The iliacus internus arises from the iliac fossa, from the internal lip of the crest of the ilium and by a few fibres from the capsular ligament of the hip-joint. It blends with the psoas magnus and is inserted with it into the trochanter minor of the femur and the bone for an inch below.

Rectus Femoris.

The rectus femoris derives its name from the straightness of its course. It arises by a forked tendon, one fork springing from the anterior inferior spinous process of the ilium, the other from the upper margin of the acetabulum. The two soon unite, and the tendon thus formed after a short course terminates in the belly of the muscle; and that in turn terminates at the lower part of the thigh in a strong tendon, which is inserted into the upper end of the patella. The fibres of this muscle have a bipenniform arrangement.

Vastus Externus.

The vastus externus arises from the base of the trochanter major, from the line leading from the trochanter major to the linea aspera, from the upper half or third of the outer lip of the linea aspera, and from the external intermuscular septum. It is inserted into the outer edge of the tendon of the rectus femoris and outer edge of the patella.

Vastus Internus.

The vastus internus arises from the whole of the shaft of the femur from the anterior intertrochanteric line downward, from the inner lip of the linea aspera, and from the internal intermuscular septum. It is inserted into the inner edge of the tendon of the rectus femoris and inner edge of the patella.

The origin of the muscle is also thus stated: from the inner surface of the shaft of the femur, from the anterior trochanteric line downward, from the front and outer faces, from the internal lip of the linea aspera and the internal intermuscular septum.

The insertion of the three muscles should be thus stated: They combine to form a common tendon, the tendon of the triceps extensor cruris, which encloses the patella as a sesamoid bone and is inserted, as the ligamentum patellæ, into the lower part of the anterior tubercle of the tibia.

The vasti muscles envelop the entire femur except the middle lip of the linea aspera and the two extremities of the bone. That portion of the vastus internus which arises from the front of the femur is sometimes described as a separate muscle under the name of the crureus.

Internal Femoral Region.

PECTINEUS.	ADDUCTOR BREVIS.
ADDUCTOR LONGUS.	ADDUCTOR MAGNUS.

The muscles of this region are adductors of the thigh, that is, they carry the thigh towards or across its fellow, and consequently they must all arise near the middle line of the body.

Pectineus.

The pectineus arises from the pectineal line and triangle of the pubes and the outer face of Gimbernat's ligament. It passes downward and is inserted into the upper part of the line leading from the trochanter minor to the linea aspera.

Adductor Longus.

The adductor longus arises from the front of the pubes just below the angle and close to the symphysis. It passes downward and outward and is inserted into the middle third of the linea aspera. This muscle and the pectineus form a layer, behind which is found the adductor brevis.

Adductor Brevis.

The adductor brevis arises from the body and ramus of the pubes. It passes downward and outward and is inserted into the whole length of the line leading from the trochanter minor to the linea aspera, its insertion extending further down than that of the pectineus.

Adductor Magnus.

The adductor magnus arises from the side of the tuber ischii and from the ischio-pubic ramus. It passes downward and outward in large distinct bundles of fibres and is inserted into the whole length of the linea aspera and by a rounded tendon into the internal condyle of the femur. This muscle is pierced by five apertures, one above the other, which transmit branches of the femoral artery. The lowest is much the largest

and transmits the termination of the femoral artery itself, over which the adductor longus and magnus throw a tendinous arch to the vastus internus, forming what is called Hunter's canal.

Scarpa's Triangle.

On the upper front part of the thigh there is an important triangle, known as Scarpa's. Its outer boundary is the sartorius, its inner the adductor longus, its base is Poupart's ligament, its apex the intersection of the sartorious and the adductor longus. Entering this triangle at the middle of its base and passing through it to disapper at its apex are the femoral artery and femoral vein.

Muscles of the Leg.

The muscles of the leg are divided into three regions, viz: 1st, anterior tibial; 2d, posterior tibial; 3d, external or fibular.

Posterior Tibial Region.

Superficial Layer.

GASTROCNEMIUS. PLANTARIS. SOLEUS.

The muscles in the posterior region are placed in two layers, superficial and deep.

Gastrocnemius.

The gastrocnemius is the large muscle which gives shape to the calf of the leg. It arises by two heads from the upper back part of the condyles of the femur and from the ridges which connect the condyles with the linea aspera. The two heads, as they descend, converge to form the lower lateral boundaries of the popliteal space, and unite to form the belly of the muscle along which a groove is continued for some distance. The belly terminates just below the centre of the leg in a large tendon called the tendo Achilles, which is inserted into the lower back part of the posterior tuberosity of the os calcis. It is the largest tendon in the body.

Action—It raises the heel, and continuing to act, raises the foot.

Soleus.

The soleus is a large fleshy muscle lying beneath the gastrocnemius. It has five points of origin, viz: the head and upper half of the posterior

aspect of the fibula, the popliteal line and middle third of the internal border of the tibia and from a tendinous arch stretched between its bony origins. The muscle descends to terminate about the middle of the leg in the tendo Achilles.

Action—Same as the gastrocnemius.

Plantaris.

The plantaris is an insignificant muscle lying between the gastrocnemius and soleus. It arises from the back part of the external condyle of the femur in common with the external head of the gastrocnemius, the belly of the muscle passing downward and inward between the gastrocnemius and soleus to terminate in a tendon which, escaping to the inner side of the two muscles, passes down either to be inserted into the posterior tuberosity of the os calcis or to be lost in the side of the tendo Achilles.

Action—Same as gastrocnemius.

The three muscles just described form the triceps suræ.

Deep Layer.

POPLITEUS.	FLEXOR LONGUS DIGITORUM.
TIBIALIS POSTICUS.	FLEXOR LONGUS POLLICIS.

Popliteus.

The popliteus is a small triangular muscle resembling the anconeus in the upper extremity. It arises by its tendinous apex from a groove on the external condyle of the femur and passes downward and inward, adhering to the head of the fibula, the posterior ligament of the knee-joint and the under surface of the fascia which covers it is inserted into the tibia above and as low down as the oblique or popliteal line on its posterior face.

Action—It flexes and inverts the leg.

Flexor Longus Pollicis.

The flexor longus pollicis arises from the lower two-thirds of the fibula, except the last inch, and from the intermuscular septum. It descends behind the internal malleolus into the sole of the foot, crosses the tendon of the flexor longus digitorum and is inserted into the base of the last phalanx of the great toe.

Action—It flexes the last phalanx of the great toe.

Flexor Longus Digitorum.

The flexor longus digitorum arises from the lower two-thirds of the tibia, except the last two or three inches, and from the intermuscular septum. It passes downward behind the internal malleolus, divides into four tendons, which are crossed by the flexor longus pollicis, and are inserted into the last phalanges of the four outer toes. Its action is indicated by its name.

Tibialis Posticus.

The tibialis posticus arises from the whole length of the posterior surface of the interosseous membrane, from the adjacent edges of the tibia and fibula and from the intermuscular septum. It descends behind the internal malleolus and is inserted into the tuberosity of the scaphoid bone and into the internal cuneiform bone.

Action—It is an extensor and adductor of the foot.

The three last muscles all arise from the interosseous membrane; and as the flexor longus pollicis arises from the outer bone of the leg and is inserted into the inner toe, it must cross the flexor longus digitorum. This crossing takes place in the sole of the foot and is known as the decussation of the tendons, which are connected at this point by a small slip.

The interosseous membrane is a strong ligamentous membrane which passes from tibia to fibula and is attached to their adjacent edges, after the manner of the interosseous membrane of the forearm. On its posterior aspect it is entirely appropriated by the tibial muscles. The muscles in the deep layer are separated from those in the superficial layer by a strong thick fascia.

Anterior Region of the Leg.

TIBIALIS ANTICUS. EXTENSOR LONGUS DIGITORUM.
EXTENSOR PROPRIUS POLLICIS.

Of the three muscles in this group two have four points of origin in common. These four points are as follows: 1st, outer tuberosity of the tibia; 2d, investing fascia of the leg; 3d, intermuscular septum; 4th, interosseous membrane.

Tibialis Anticus.

The tibialis anticus arises from the common origin and from the upper two-thirds of the outer face of the tibia. It passes downward to termi-

nate in a tendon which runs beneath the anterior annular ligament and is inserted into the inner and under surface of the internal cuneiform bone and into the base of the metatarsal bone of the great toe.

Action—It flexes the foot; and, according as it acts with the tibialis posticus or the peronei, it inverts or everts the foot.

Extensor Longus Digitorum.

The extensor longus digitorum arises from the common origin and from the head and whole length of the shaft of the fibula. It descends and divides into five tendons, which pass beneath the anterior annular ligament and are inserted as follows: one into the base of the metatarsal bone of the little toe, the other four into the backs of the four lesser toes after the manner of extensor tendons. That part of the muscle inserted into the base of the metatarsal bone of the little toe, and arising from the lower fourth of the fibula, is sometimes called the peroneus tertius.

Action—It extends the toes; and, by its insertion into the metatarsal bone of the little toe, flexes the foot.

Extensor Proprius Pollicis.

The extensor proprius pollicis is shorter than the two preceding muscles and lies between and is overlapped by them. It arises from the middle two-fourths of the shaft of the fibula and from the interosseous membrane, and terminates in a tendon which passes beneath the anterior annular ligament and is inserted into the base of the last phalanx of the great toe. Its action is indicated by its name.

The anterior annular ligament is a strong oblique ligamentous band which binds the tendons of the three preceding muscles down on the front of the ankle.

External Region of the Leg.

PERONEUS LONGUS. PERONEUS BREVIS.

Peroneus Longus.

The peroneus, or fibularis, longus arises from the head and upper two-thirds of the outer aspect of the shaft of the fibula, from the investing fascia and the intermuscular septum. It descends to terminate in a tendon which passes behind the external malleolus, through the lower groove on the outer surface of the os calcis, reaches the sole of the foot and is

directed across it obliquely forward and inward, through a groove in the cuboid bone, to be inserted into the base of the metatarsal bone of the great toe.

Action—It is an extensor of the foot.

Peroneus Brevis.

The peroneus, or fibularis, brevis derives its name from its position and because its origin and insertion are both short of the preceding muscle, beneath which it lies. It arises from the lower two-thirds of the outer aspect of the shaft of the fibula and from the intermuscular septum, descends behind the external malleolus, through the upper groove on the outer surface of the os calcis, and is inserted into the base of the metatarsal bone of the little toe.

Action—It extends the foot.

The two peronei muscles, as they are passing the outer malleolus, are held down by the external annular ligament.

Muscles of the Foot.

The foot is divided into two regions, dorsal and plantar.

Dorsum of the Foot.

Extensor Brevis Digitorum.

The extensor brevis digitorum arises from the upper and outer aspect of the os calcis and passing forward and inward divides into four tendons the innermost of which is inserted into the base of the first phalanx of the great toe, the other three into the backs of the next three toes in common with the long extensor tendons.

Its name indicates its action.

The Sole of the Foot.

When the thick skin on the sole of the foot has been removed, there is brought into view a thick mass of fatty tissue and beneath this a strong fascia called the plantar fascia. It consists of a strong, thick central portion and, on either side, continuous with this, a thinner lateral portion. The central portion begins behind at the under surface of the os calcis, runs forward and just beyond the middle of the sole divides into five branches each of which passes forward to the base of a corresponding

toe. The muscles of the sole all lie beneath (or, in the erect position, above) this fascia and are divided into groups in accordance with the subdivisions of the plantar fascia, viz: a central and two lateral groups. The propriety of this division is shown by the fact that the plantar fascia sends up to the bone intermuscular or dividing septa from the line of union of the central and two lateral portions.

In describing these muscles, however, they are taken in layers, of which there are three. When the plantar fascia, the dissection of which is the first step, has been removed, the first layer, consisting of one muscle in each group, is exposed. This constitutes the *second view* in the dissection of the sole.

First Layer.

ABDUCTOR POLLICIS. ABDUCTOR MINIMI DIGITI.
FLEXOR BREVIS DIGITORUM.

The three muscles forming the first layer have a common origin, viz: 1st, the under surface of the os calcis; 2d, the plantar fascia which covers them; 3d, the intermuscular septa which separate them. Some of the plantar fascia should be left on the muscles in dissecting them, since it is a part of their origin.

Abductor Pollicis.

The abductor pollicis is the innermost of the three muscles of the first layer. It arises from the common origin and is inserted into the inner side of the base of the first phalanx of the great toe.

Its name indicates its action.

Abductor Minimi Digiti.

The abductor minimi digiti is the outer of the three muscles in the first layer. It arises from the common origin and is inserted into the outer side of the base of the first phalanx of the little toe.

Its name indicates its action.

Flexor Brevis Digitorum.

The flexor brevis digitorum lies in the centre of the first layer. It arises from the common origin, passes forward and divides into four tendons for the four lesser toes. Each tendon splits to allow the passage of the tendon of the long flexor and is inserted into the sides of the shaft of the second phalanx.

Its name indicates its action.

Second Layer.

MUSCULUS ACCESSORIUS. LUMBRICALES.

The second layer, exposed by removing the first, is the third view in the dissection of the sole. It consists of the musculus accessorius, the lumbricales and the tendons of the flexor longus pollicis and flexor longus digitorum. These two tendons, soon after entering the sole from behind the internal malleolus, cross each other forming their decussation and are also connected by slips so that one muscle cannot act independently of the other, but throws the part to which it is attached into slight motion.

Musculus Accessorius.

The musculus accessorius arises tendinous and fleshy from the under surface of the os calcis and passing forward is inserted into the outer side and upper surface of the tendon of the flexor longus digitorum just as it splits into its four branches.

Action—It corrects the obliquity which would otherwise be imparted to the four lesser toes by the action of the long flexor.

Lumbricales.

The lumbricales are four little worm-like muscles, three of which arise from the bifurcation of the tendon of the flexor longus digitorum, while the fourth springs from the inner side of the inner tendon of that muscle. They pass between the toes and are inserted into the tibial side of the extensor tendons of the four lesser toes.

Action—They aid the flexor longus digitorum.

Third Layer.

FLEXOR BREVIS POLLICIS. FLEXOR BREVIS MINIMI DIGITI.
ADDUCTOR POLLICIS. TRANVERSUS PEDIS.

This layer, constituting the fourth layer in the dissection of the sole of the foot, is exposed by removing the second layer.

Flexor Brevis Pollicis.

The flexor brevis pollicis arises from the cuboid bone, the external cuneiform bone and the expanded tendon of the tibialis posticus. It is

inserted into both sides of the base of the first phalanx of the great toe, each tendon having a sesamoid bone in it.

Adductor Pollicis.

The adductor pollicis arises from the cuboid bone, from the sheath of the tendon of the peroneus longus and from the bases of the adjoining metatarsal bones (second, third and fourth). It is inserted into the outer side of the base of the first phalanx of the great toe.

Flexor Brevis Minimi Digiti.

The flexor brevis minimi digiti arises from the base of the fifth metatarsal bone and is inserted into the outer side of the base of the first phalanx of the little toe.

Transversus Pedis.

The transversus pedis arises by slips from the heads of the four outer metatarsal bones, and passing inward is inserted into the outer side of the base of the first phalanx of the great toe.

Action—It is an adductor of the great toe.

Interosseous Muscles.

Lying between the metacarpal bones of the hand and the metatarsal bones of the foot are certain small muscles called from their position interosseous. In each member there are seven of these muscles, four dorsal and three plantar. They are bipenniform muscles, arising from the metacarpal or metatarsal bone and inserted into the first phalanx. The first dorsal interosseous of the hand is much larger than the others and is called the abductor indicis.

The Vascular System.

The vascular system comprises three sets of vessels—1st, capillaries, minute vessels, ramifying in all parts of the body; 2d, veins, the channels for transmission of the deoxygenated blood back to the centre of circulation; 3d, arteries, the vessels which carry the blood from the heart to the capillaries.

THE ARTERIES.

The arterial system consists of two parts, the pulmonary and the systemic. The pulmonary is formed by the pulmonary artery, and its branches convey venous blood from the right ventricle to the lungs. The systemic consists of the aorta and its branches, which convey arterial blood to all parts of the body.

The branches of the aorta, in the aggregate, greatly exceed the size of the aorta from which they are all remotely derived; and the capillaries, in the aggregate, are indefinitely larger than the arteries themselves. The progress of the blood is, therefore, much slower as the size of the channel increases in proportion to its remoteness from the centre of circulation; and the course of the blood is still more retarded by the tortuousness of some of the arteries, thus protecting their delicate coats.

As a rule arteries seek the most sheltered route they can obtain, avoiding the surface and lying near bone when practicable. When passing through muscular parts they seek the interstices between muscles; and when forced to perforate a muscle the aperture is always surrounded by a tendinous arch to avoid the compression of the artery, which would otherwise result, when the muscle contracted. Another provision for their safety is the fibrous sheath which isolates the arteries from the structures through which they pass, and protects them from inflammation or other disease which may affect the part.

The names of arteries are, as a rule, derived from the parts which they occupy or which they are intended to supply. As a rule the name of an artery remains unchanged, irrespective of the number or size of the branches it gives off, until it divides into two or more terminal branches. The two exceptions to this rule are found in the arteries of the upper and lower extremities, which are known under different names in different parts before they divide.

Another noteworthy point is that arteries usually supply the parts through which they course, so that they are constantly diminishing in size. The walls of the arteries do not absorb the blood they transmit, but are nourished by vessels of their own called vasa vasorum.

The arteries are usually accompanied by the veins which return the blood from the parts which the arteries supply. The veins may be single, when they bear the name of the artery they accompany, or double,

when they lie one on either side of the artery, and are known as satellite veins or venæ comites. The venous channel from a part is generally about twice the size of the arterial to it, and consequently the venous current is much slower than the arterial; it increases in speed, however, as it approaches the heart, owing to the diminishing size of the channel.

Pulmonary Artery.

The pulmonary artery begins at the base of the venous ventricle of the heart, the infundibulum, or conus arteriosus of that cavity leading up to it. Its origin is opposite the upper border of the third costal cartilage of the left side, close to the edge of the sternum, in front of and slightly above and to the right of the origin of the aorta. It is about two inches in length, its direction being upward, backward and very slightly to the left. It lies in the fibrous pericardium, which it pierces and immediately divides into the right and left pulmonary arteries. It and the ascending part of the arch of the aorta are contained in the same fold of serous pericardium.

It first lies on the front of the ascending part of the arch of the aorta but soon gets to the left of that vessel, more on account of the obliquity of the aorta than its own inclination to the left.

On each side of its origin is an appendix of a corresponding auricle and a coronary artery. Its bifurcation is immediately below the transverse part of the arch of the aorta; from the left branch of the pulmonary artery, near its bifurcation, there springs a fibrous cord about half an inch long, the remains of the ductus arteriosus which connects it with the arch of the aorta.

The two terminal branches, the right and left pulmonary arteries, pass almost horizontally outward for about two inches each to the inner face of the corresponding lung, where it bifurcates for distribution to the lung. The right is slightly larger than the left and somewhat longer. It passes behind the ascending part of the arch of the aorta and the superior vena cava. The left passes in front of the descending part of the arch. Each forms an element in the root of the lung, lying between the bronchus behind and the two pulmonary veins in front. The right is on a lower, the left on a higher level than the corresponding bronchus.

The Aorta.

The aorta begins at the base of the arterial ventricle and terminates by dividing into the common or primitive iliac arteries on the front of the

body of the fourth lumbar vertebra, usually a little to the left of the middle line. It lies first in the thoracic cavity and then in the abdominal. It first passes upward, forward and to the right in the fibrous pericardium, pierces the pericardium and arches backward and to the left, with its convexity upward, and strikes the thoracic portion of the vertebral column at the left side and lower border of the body of the fourth dorsal vertebra, and then descends beside the body of the fifth dorsal vertebra with a slight inclination to the right. From the left side of the lower border of the fifth dorsal vertebra it descends, steadily inclining to the right, to a point opposite the twelfth dorsal vertebra usually a little to the left of the middle line, where it passes from the thorax into the abdomen through the aortic opening in the diaphragm. From this point its course is down the front of the lumbar vertebræ, generally inclining to the left, to its termination.

For convenience of description it is divided into the arch of the aorta and the descending aorta. The arch of the aorta begins at the base of the left ventricle and extends to the left side and lower border of the fifth dorsal vertebra. It is subdivided into the ascending, transverse and descending parts of the arch. The descending aorta begins where the arch terminates at the lower border and left side of the body of the fifth dorsal vertebra, and includes the remainder of the artery. It is divided into the thoracic aorta, and the abdominal aorta in accordance with the cavity in which it lies.

The Arch of the Aorta.

Ascending Part.

The ascending part of the arch of the aorta, or as it is frequently called, the ascending aorta, begins at the base of the arterial ventricle of the heart, at a point behind the left edge of the sternum, at the third intercostal space, on a plane posterior to the origin of the pulmonary artery and anterior to the left auriculo-ventricular opening. It is about two inches in length. It is directed upward, to the right and slightly forward, presenting a slight curve in its course with its convexity to the right: it terminates in the transverse part of the arch where it pierces the pericardium, opposite the right edge of the sternum, behind the upper border of the second costal cartilage of the right side. Just above its origin it presents, when distended, three bulging prominences which correspond to the sinuses of Valsalva. It lies in the fibrous pericardium, about one-fourth of an inch behind the sternum, and is contained in the same fold of serous pericardium as the pulmonary artery.

It first lies behind the pulmonary artery, but quickly gets to the right of that vessel, owing mostly to its own inclination to the right. Above the point where the pulmonary artery leaves its front it is separated from the sternum by the pericardium, some loose connective tissue and perhaps the remains of the thymus gland. It is overlapped in front, at its origin, by the right auricular appendix. Behind it is the root of the right lung. To the right is first the right auricle and then the superior vena cava. To the left is the pulmonary artery.

Transverse Part.

The transverse part of the arch of the aorta begins where the ascending part pierces the pericardium behind the right edge of the sternum, on a level with the upper border of the second costal cartilage of the right side. Its course is curved with its convexity upward, its direction being to the left and backward. It strikes the left side and lower border of the body of the fourth dorsal vertebra and terminates there by becoming the descending part of the arch of the aorta.

The top of the arch is about an inch below the top of the sternum, and from this aspect arise three large branches, the arteria innominata, left common carotid and left subclavian. Resting on the arch, in front of the origin of these branches, is the left vena innominata or great transverse vein of the neck.

Below it is the bifurcation of the pulmonary artery to which it is connected by the remains of the ductus arteriosus. Below it also is the left bronchus and the left recurrent or inferior laryngeal nerve. This nerve springs from the pneumogastric as it is lying on the front of the artery, passes below it and finally winds up behind it, bearing thus a three-fold relation to the artery.

This portion of the arch is separated from the sternum by the left pleura, the anterior border of the left lung and the remains of the thymus gland. It is crossed from above downward, on its front aspect, by two great nerves, the left pneumogastric and the left phrenic, the phrenic being directly in front of the pneumogastric and both lying to the left of the middle line.

Behind the transverse part of the arch, on the middle line, we have first the trachea and behind that the œsophagus, and to the left of these the thoracic duct and left recurrent laryngeal nerve.

Descending Part of the Arch.

The descending part of the arch of the aorta begins where the transverse part terminates, at the left side and lower border of the body of the fourth dorsal vertebra. It runs downward, with a slight inclination to the right, to terminate by becoming the thoracic portion of the descending aorta at the left side and lower border of the body of the fifth dorsal vertebra.

In front is the root of the left lung, behind, the body of the fifth dorsal vertebra; to the left, the left pleura and lung; to the right, the œsophagus and thoracic duct.

The Thoracic Aorta.

The thoracic portion of the descending aorta begins by being a continuation of the descending part of the arch of the aorta at the left side and lower border of the body of the fifth dorsal vertebra and terminates by becoming the abdominal portion of the descending aorta at the aortic opening in the diaphragm opposite the front of the body of the twelfth dorsal vertebra generally slightly to the left of the middle line. Its direction is downward and steadily but slightly to the right, and presents a curve with a slight concavity in front to correspond with the dorsal portion of the vertebral column on which it rests.

It lies in the posterior mediastinum, behind the pericardium, covered in front and to the left by the left pleura and lung. Its most important relations are the thoracic duct and the œsophagus. The thoracic duct is continuously behind and slightly to the right. The œsophagus, on which are the two pneumogastric nerves, lies at first to the right but as it descends gets gradually in front of the aorta and terminates by piercing the diaphragm opposite the tenth dorsal vertebra not only in front but to the left. To the right is the right or great azygos vein, opening into which, about the sixth dorsal vertebra, is the left azygos vein which crosses behind the aorta.

The Abdominal Aorta.

The abdominal portion of the descending aorta begins by being a continuation of the thoracic portion at the aortic opening in the diaphragm (behind the diaphragm really) opposite the twelfth dorsal vertebra and slightly to the left of the middle line, and terminates by dividing into the common or primitive iliacs on the front of the body of the fourth

lumbar vertebra, usually slightly to the left of the middle line but frequently on it. Its direction is downward and generally slightly to the left, presenting a slight curve with its convexity forward in conformity with the lumbar portion of the spine upon which it rests. It is markedly smaller at its termination, owing to the size and member of the branches which it gives off.

In front it has the stomach, upon either side the two semilunar ganglia of the sympathetic system, forming, by their branches, the solar plexus of nerves on the front of the aorta; next comes the head of the pancreas, and immediately below this the left renal vein, the transverse portion of the duodenum and the mesentery. Below this it is covered in front and at the sides by the peritoneum and the aortic plexus of sympathetic nerves.

Behind its upper part, opposite the second lumbar vertebra, is the commencement of the thoracic duct, the receptaculum chyli, and it is separated from the lumbar vertebræ by the left lumbar veins. To the left are the left crus of the diaphragm and part of the sympathetic nerves. To the right are the right crus of the diaphragm, the inferior vena cava and, at its upper part, the right vena azygos and thoracic duct.

The termination of the abdominal aorta corresponds to a point on the anterior abdominal wall half an inch below and to the left of the umbilicus, about on a level with a line drawn between the highest parts of the crests of the ilia.

Branch of the Ascending Aorta.

The branches of the ascending aorta are two small arteries called coronary, left or anterior and right or posterior, which are distributed to the heart. These arise close to the origin of the aorta and run in the anterior and posterior interventricular furrows, meeting at the apex of the heart and in the auriculo-ventricular grooves, thus forming around the heart two vascular zones, one vertical and one horizontal.

Branches of the Arch of the Aorta.

The branches of the arch of the aorta are three. The one to the right is the arteria innominata, destined to supply the right side of the head and neck and right upper extremity; the middle branch is the left common carotid, supplying the left side of the head and neck; the left branch is the left subclavian, whose field of distribution is the left upper extremity. The arteria innominata supplies parts corresponding to those

supplied by both the left common carotid and left subclavian, and is, in fact, the fused right common carotid and subclavian.

Arteria Innominata.

The arteria innominata is the first and doubly the largest branch of the arch of the aorta. It arises at the commencement of the transverse part of the arch of the aorta and passes upward and to the right for a little less than two inches to terminate behind the upper border of the right sterno-clavicular articulation by dividing into the right common carotid and right subclavian arteries.

Relations—In front of it is the sternum, some loose connective tissue, and, near its origin, the left vena innominata. Behind, at its commencement, is the trachea; but, owing to the obliquity of the artery, it soon gets to the right of the trachea, which then lies on the left side of the arteria innominata. On the right is the right vena innominata and the right pleura. On the left, at its commencement, is the left common carotid artery, separated from it by a triangular interval in which the trachea may be seen. It produces none but its terminal branches.

The Right Common Carotid.

The common carotid artery of the right side springs from the bifurcation of the arteria innominata, while the left common carotid is a branch of the arch of the aorta; consequently the left is as long as the right and the arteria innominata added together, and the relations of that portion corresponding to the arteria innominata will be similar to but not identical with that vessel. From behind the left sterno-clavicular articulation to its termination a description of the left common carotid will apply to the right also.

The right common carotid begins where the arteria innominata terminates, behind the upper border of the right sterno-clavicular articulation, and passes upward lying on the front of the anterior tubercles of the transverse processes of the cervical vertebræ, separated from them by the prævertebral group of muscles, as high as the fourth, or on a line with the upper border of the thyroid cartilage, where it terminates by dividing into the external and internal carotid arteries. In the female it usually terminates slightly below this level.

Relations—The prævertebral group of muscles separates it from the anterior tubercles of the transverse processes of the cervical vertebræ as high as the fourth and the sympathetic nerve, with a ganglion on its

upper portion, lies behind it on these muscles. It is contained in a strong fibrous sheath, which also contains the internal jugular vein, separated from the artery by a partition, and the pneumogastric nerve. The vein is external to the artery while the nerve lies behind and between the two. Descending on the front of the upper portion of the sheath is a nerve, called descendens noni, a branch of the hypoglossal, which sometimes pierces the sheath and descends within it. Just below the middle of the neck, about the central tendon of the omo-hyoid muscle, this nerve joins a branch from the second and third cervical called the communicans noni, forming Scarpa's arch on the front of the sheath. To the inner side of the artery, separating it from its fellows of the opposite side, are, in the first part of its course the trachea, then the larynx and thyroid gland. These structures widen as the artery ascends, and the two arteries appear to be further apart and situated farther back above than below. The arteries are, however, more superficial above than below. The recurrent laryngeal nerve crosses behind the artery making for its destination, as does the inferior thyroid artery, a branch of the subclavian. The following structures cover the artery in front, in the order given: 1st, integument; 2d, platysma myoides; 3d, sterno-cleido-mastoid; 4th, sterno-hyoid; 5th, sterno thyroid; 6th, anterior belly of omo-hyoid. The platysma is an universal covering of the artery; the sterno-cleido-mastoid covers it from its commencement to within a short distance of its termination; the point where it draws off to the outer side corresponding to the point where the omo-hyoid crosses it, *i. e.*, about the middle of the neck, opposite the cricoid cartilage where the artery enters the superior carotid triangle at its apex, emerging from beneath the anterior belly of the omo-hyoid and sterno-cleido-mastoid and passing up to about the middle of the triangle where it bifurcates. All that portion of the artery lying in the superior carotid triangle is superficial, being covered only by the integument and platysma myoides. The sterno-hyoid and sterno-thyroid muscles cover only about two inches of the artery, drawing off then to its inner side. At its origin the artery has in front the integument, fascia, platysma myoides, deep fascia, origin of the sterno-cleido-mastoid, the sterno-clavicular articulation of the right side and the origins of the sterno-hyoid and sterno-thyroid muscles.

The course of the artery can be thus indicated: draw a transverse line from the upper border of the thyroid cartilage to the anterior edge of the sterno-cleido-mastoid muscle and a vertical line from the sterno-clavicular articulation to the point where the transverse line intersects the sterno-cleido-mastoid. The artery will lie behind the vertical line.

The artery is preferably tied where it is crossed by the anterior belly of the omo-hyoid. The arch of Scarpa is found on the front of the sheath at this point.

The common carotid is divided by surgeons into two portions. The first portion extending from its origin to the point where it is crossed by the omo-hyoid, the second, from this point to its termination. Some make three portions, the first lying in the inferior carotid triangle, the second being the part crossed by the anterior belly of the omo-hyoid, and the third lying in the superior carotid triangle.

External Carotid.

The external carotid artery, one of the two terminal branches of the common carotid, begins where that artery bifurcates about on a level with the upper border of the thyroid cartilage and, continuing the direction of the common carotid, passes beneath the posterior belly of the digastric and the stylo-hyoid muscles, enters the substance of the parotid gland and terminates in that gland behind the neck of the condyle of the lower jaw by dividing into two branches, the temporal and the internal maxillary arteries. The temporal continues the course of the external carotid to mount over the zygoma and be distributed to the side of the head by two branches, while the internal maxillary passes inward, behind the neck of the condyle of the lower jaw, to supply the deep structures of the face.

The first portion of the external carotid lies in the superior carotid triangle, its length varying as the common carotid divides on a level with, above or below the upper border of the thyroid cartilage; for it extends from the bifurcation of the common carotid to the stylo-hyoid and posterior belly of the digastric. It is covered by the integument and platysma and is crossed in front by the hypoglossal or twelfth nerve. At its commencement the internal carotid lies to its outer side; but by the time the external carotid reaches the termination of its first portion, the internal carotid has passed behind it. The second portion is that which is crossed by the stylo-hyoid and posterior belly of the digastric. Its coverings are integument, platysma, stylo-hyoid and posterior belly of the digastric. The third and last portion extends from the stylo-hyoid and posterior belly of the digastric to the termination of the artery behind the neck of the condyle of the lower jaw. It lies embedded in the substance of the parotid gland and is crossed, superficially, near its termination, by the facial nerve. The first portion is most superficial, the second the shortest and the third the longest and deepest.

Branches.

SUPERIOR THYROID.	OCCIPITAL.
LINGUAL.	POSTERIOR AURICULAR.
FACIAL.	ASCENDING PHARYNGEAL.

PAROTIDEAN.

It should be remembered that the common carotid gives off no branches until it terminates, and hence the structures in its course have to be supplied by other arteries. The external carotid does a part of this work. Besides those into which it divides, the external carotid gives off six single branches, and a set to the parotid gland. The first three arise from the anterior aspect of the artery, low down and in the order given from below upward. The next two rise from the back of the artery higher up.

I. Superior Thyroid.

The superior thyroid forms a curve, first passing upward and inward, then downward and inward, crossing beneath the depressor muscles of the hyoid bone, and reaches the upper part of the thyroid gland to which it is distributed. It gives off the following branches:

1st. Hyoid, which passes forward just beneath the hyoid bone to be distributed to muscles.

2d. Superior laryngeal, which passes forward on the thyro-hyoidean membrane and pierces it to be distributed to the mucous membrane of the larynx.

3d. Inferior laryngeal, or crico-thyroid, which passes across the crico-thyroid membrane and gives branches which pierce it to reach the mucous membrane of the larynx.

4th. Muscular or superficial descending branches, which passes downward and outward across the common carotid.

II. Lingual.

The lingual artery is divided into four portions: 1st, it descends obliquely inward, over the extremity of the hyoid bone covered only by the skin and platysma; 2d, it passes forward along and above the hyoid bone covered by the hyo-glossus muscle; 3d, it ascends to the under aspect of the tongue; 4th, it runs forward on the under aspect of the tongue, under the name of the ranine artery. The first two portions lie on the middle constrictor of the pharynx. Its branches are three:

1st. Hyoid, which runs inward along the upper border of the hyoid bone to be distributed to muscles.

2d. Dorsalis lingualis, which ascends to the dorsum of the tongue along the posterior border of the hyo-glossus muscle.

3d. Sublingual, which runs forward to the sublingual gland and to muscles.

III. Facial.

The facial artery arises just above the hyoid bone and is divided into two portions, one while it is in the neck and the other after it reaches the face. The first portion passes forward and upward, through the submaxillary gland, to mount over the body of the lower jaw just at the anterior inferior angle of the masseter muscle and about one and one-half inches in front of the angle of the lower jaw. At its origin it is superficial, being covered only by the skin and platysma; but it soon enters the submaxillary gland and is crossed by the stylo-hyoid and posterior belly of the digastric. When it leaves the gland and mounts over the jaw it is again superficial, being covered only by the integument and platysma. Its pulsations can here be felt. The second portion of the artery has a tortuous upward and inward course over the face towards the angle of the mouth, thence along the side of the nose to terminate at the inner canthus of the eye as the angular artery. Its branches are divided into those given off below the jaw, five in number, and those on the face, also five in number.

1st. Inferior palatine, which ascends to the soft palate.

2d. Tonsillar, which ascends to the tonsils.

3d. Submaxillary, which are from three to five in number and ascend to the submaxillary gland.

4th. Submental, which runs forward beneath the lower jaw and passing over the symphysis menti terminates by inosculating with the inferior labial.

5th. Muscular branches distributed to neighboring muscles.

The five branches from the second portion are as follows:

1st. Muscular, or Buccal, which are branches to adjacent muscles.

2d. Inferior labial, which runs forward beneath the lower lip.

3d. Inferior coronary, which skirts the edge of the lower lip.

4th. Superior coronary, which skirts the edge of the upper lip, giving off a branch to the septum of the nose, arteria septi.

5th. Lateralis nasi, which is distributed to the side of the nose, inosculating with its fellow of the opposite side.

IV. Occipital.

The occipital branch of the external carotid passes upward and backward to the occipital groove of the temporal bone, beneath the muscles attached to the mastoid process, thence mounting on the posterior aspect of the occipital bone and piercing some of the deep muscles of the back it becomes superficial and is distributed to the back of the head. Its branches are two:

1st. Sterno-mastoid, which, sometimes arising directly from the external carotid, descends to muscles and glands.

2d. Princeps cervicis, which passes down the neck lying deep. It inosculates with the cervicalis ascendens from the subclavian and is of importance in establishing collateral circulation after ligation of the common carotid.

V. Posterior Auricular.

The posterior auricular passes upward and backward behind the ear and is distributed by an anterior branch to the auricle and by a posterior to the back of the head. It produces one branch, the stylo-mastoid, which enters the stylo-mastoid foramen to be distributed to the ear.

VI. Parotidean Branches.

The parotidean branches, four or five in number, are distributed to the parotid gland as the external carotid is passing through it.

Ascending Pharyngeal.

The ascending pharyngeal branch springs from the external carotid just at its origin and passes up beside the pharynx to the base of the skull, where it divides into a meningeal branch to enter the cavity of the cranium through the jugular foramen, and a pharyngeal branch to adjacent parts.

The Temporal Artery.

The temporal artery, one of the two terminal branches of the external carotid, begins where the external carotid forks in the parotid gland, behind the neck of the condyle of the lower jaw, and emerging mounts over the zygoma and divides about one and one-half inches above that point, where it lies on the temporal fascia, into an anterior and a posterior temporal. The anterior passes upward and forward, the posterior upward

and backward to be distributed to the side of the head. These two are called the superficial temporal branches since, as will appear hereafter, there are other and deeper temporal branches.

It gives rise to four branches besides those in which it terminates.

1st. Transverse, facial which arises below the zygoma, and passes transversely forward on the masseter muscle parallel with Steno's duct.

2d. Anterior auricular, to the front of the auricle.

3d. Orbital, which runs forward to the outer angle of the eye.

4th. Middle temporal, which plunges into the substance of the temporal muscle where it is distributed. Its name is derived from its situation between the two superficial temporal arteries and the deep which spring from another trunk.

The Internal Maxillary.

The internal maxillary is the larger of the two terminal branches of the external carotid. The course of the artery is divisible into three portions. The first portion passes inward, forward and upward behind the ramus of the inferior maxilla, between it and the internal lateral ligament. The second portion passes forward and upward between the internal pterygoid muscle within and the temporal and masseter muscle without. The third portion disappears into the spheno-maxillary fossa. Its branches are sixteen in number, as follows:

First Portion—Four Branches.

1st. Tympanic, which enters the tympanum through the fissure of Glaser.

2d. Meningea media, which ascends to enter the cavity of the cranium through the foramen spinosum.

3d. Meningea parva, which enters the cavity of the cranium through the foramen ovale.

4th. Inferior dental, which descends to enter the dental foramen of the inferior maxilla and runs forward in the bone giving a branch to each fang of every tooth in the lower jaw. Just before entering the dental foramen it gives off a branch called mylo-hyoidean; and when it reaches the mental foramen it divides, sending a branch called mentalis through the mental foramen, while another, called the incisive, continues its course in the bone.

Second Portion—Six Branches.

These six branches are collectively known as the muscular branches and are distributed to the five muscles of mastication, each muscle receiving one branch, except the temporal which has two, which, lying beneath the muscle on the bone, are known as the deep temporal arteries.

Third Portion—Six Branches.

1st. Superior dental, which descends upon the tuberosity of the superior maxilla and sends its branches through small foramina in the bone to supply the teeth of the upper jaw.

2d. Infra-orbital, which runs forward along the canal in the floor of the orbit, sending branches downward to the front teeth of the upper jaw and emerges through the infra-orbital foramen to supply adjacent parts on the face.

3d. Spheno-palatine, which enters the nose through the spheno-palatine foramen and divides into two branches, one being distributed to the septum and the other to the mucous membrane of the outer wall and antrum maxillare.

4th. Descending palatine, which descends along the posterior palatine canal to emerge in the palate through the posterior palatine foramen and send a branch forward in a groove seen on the side of the hard palate (called the anterior palatine canal) which reaches the floor of the nose through the anterior palatine foramen.

5th. Pterygo-palatine, which runs backward in the pterygo-palatine canal to the pharynx, Eustachian tube and neighboring parts.

6th. Vidian, which passes backward along the pterygoid canal and, like the preceding, is distributed to the mucous membrane of the pharynx and Eustachian tube.

The Right Subclavian.

The right subclavian is the first subdivision of the artery of the upper extremity, which is known under three different names before it divides. It begins by being one of the terminal branches of the arteria innominata behind the upper border of the right sterno-clavicular articulation and arches outward forming a bow whose convexity is upward, first passing upward and outward, then outward to the top of the bow, and then downward and outward to pass obliquely beneath the clavicle and terminate at

the outer border of the first rib, beneath the junction of the outer one-third with the inner two-thirds of the clavicle by becoming the axillary artery.

The top of the arch lies just behind the scalenus anticus muscle, a relation which warrants the division of the artery into three portions: the first portion extends from the origin of the artery upward and outward to the inner edge of the muscle; the second portion, the top of the bow, extends from there to the outer edge, or lies behind the scalenus anticus; the third portion passes downward and outward from the outer edge of the scalenus anticus to the termination of the artery. This portion may itself be divided into two parts, viz: that part which lies above the clavicle and that which lies behind it. The third portion disappears beneath the clavicle about the middle of the bone, but its obliquity is so great that it emerges at the junction of the outer and middle thirds.

Relations.

Covering the artery universally are the integument, fascia and platysma myoides. In front of its origin are the structures which lie in front of the termination of the arteria innominata or the origin of the right common carotid, viz: integument, fascia, platysma, sterno-cleido-mastoid, sterno-clavicular articulation, sterno-hyoid and sterno-thyroid muscles. Owing to the outward direction of the artery the relation to these muscles is quickly lost.

Lying to the inner side of the commencement of the artery is the right common carotid, and descending in the sheath with that vessel, the internal jugular vein is found, which crosses the front of the first portion and unites just beneath it with the subclavian vein to form the right vena innominata. The pneumogastric nerve, also lying to the outer side of the common carotid, crosses the front of the first portion, giving off, as it lies on the front, the right recurrent laryngeal which sweeps below and then winds up behind the artery, bearing the same relation to the subclavian that the left recurrent laryngeal does to the transverse part of the arch of the aorta. As the subclavian artery lies at the root of the neck, and the thoracic cavity lined by the pleura, extends one and one-half inches into the root of the neck, the pleura will be found lying below and behind the artery in all of its course until the two are separated by the first rib, on which the greater part of the third portion rests.

A point of interest is the extent of the artery covered by the sterno-cleido-mastoid. This muscle usually covers the first and second portion;

but, owing to the variations in its clavicular origin, it may barely cover the first two portions, or, having a redundant origin, it may cover all or a part of the third portion.

The different parts studied separately:

First Portion.

The first portion begins where the artery begins and passing upward and outward terminates in the second portion at the inner edge of the scalenus anticus muscle. It is covered throughout by the integument, platysma and sterno-cleido-mastoid and at its commencement by the right sterno-clavicular articulation, the sterno-hyoid and sterno-thyroid muscles. Crossing its front are the pneumogastric and, generally, the phrenic nerves, though the latter sometimes crosses the second portion lying on the scalenus anticus, and the internal jugular vein, which, just as it has crossed the front of the artery, unites with the subclavian vein to form the right vena innominata. The pneumogastric gives off, as it passes over the front, the recurrent laryngeal which bears a triple relation to the artery, viz: behind, below and in front.

To the inner side of the commencement is the right common carotid artery.

Beneath the artery rests on the pleura, which extends up behind it. In this part of its course the artery has below it the subclavian vein, which forms a string to the subclavian bow, the vein running transversely inward behind the clavicle while the artery arches half an inch above it, and the two are in relation again only at the inner aspect of the termination of the artery.

Second Portion.

The second portion forms the top of the bow and runs transversely outward. It lies behind the scalenus anticus muscle and is coextensive with its breadth.

In front are the integument, platysma, sterno-cleido-mastoid and scalenus anticus muscles, and occasionally the phrenic nerve.

Behind and above it, separating it from the scalenus posticus, is the brachial plexus of nerves.

Below and behind are the pleura.

The subclavian vein is some distance below this portion, lying behind the clavicle and in front of the scalenus anticus muscle.

Third Portion.

The third portion of the subclavian is the downward and outward portion, extending from the outer edge of the scalenus anticus muscle to the outer border of the first rib and lying first between the scaleni muscles and then between the clavicle and first rib.

It is covered entirely by the platysma and possibly partially, or even totally, by a redundant origin of the sterno-cleido-mastoid muscle, while of course it is crossed by the clavicle. Crossing its front are two vessels, an artery and a vein. The supra-scapular artery, a branch of the subclavian itself, passes outward just beneath the upper border of the clavicle. The other vessel, the external jugular vein, descends the neck lying just behind the outer edge of the sterno-cleido-mastoid muscle, and, after receiving on the front of the artery the supra-scapular and transverse cervical veins, terminates usually in the subclavian vein to the outer side of the scalenus anticus. To the outer side is the brachial plexus of nerves. To the inner side is the subclavian vein, which, however, is in contact only for a short distance from the termination of the artery. At its very commencement the pleura lies behind and below, but is soon cut off by the first rib.

The subclavian is preferably ligated in the third portion where it is lying on the first rib, the clavicle being moved off by forcibly depressing the shoulder. This point is selected for the following reasons: it is most accessible; it is most remote from the branches of the artery; which all come from the first and second portions. It is separated from the pleura by the first rib.

Branches.

VERTEBRAL.	TRANSVERSA COLLI.
INFERIOR THYROID.	INTERNAL MAMMARY.
SUPRA SCAPULAR.	SUPERIOR INTERCOSTAL.

CERVICALIS PROFUNDA.

These seven branches usually arise by four trunks, viz: the vertebral, thyroid axis, internal mammary and the common trunk for the superior intercostal and cervicalis profunda.

The word "axis" in arterial anatomy means a short trunk which quickly divides into at least three branches.

The branches which the thyroid axis produces are usually the inferior thyroid, supra-scapula and transversa colli though they vary greatly.

The inferior thyroid is the most constant of its progeny and gives its name to the axis.

I. Vertebral.

The vertebral artery, the first and largest branch of the subclavian, arises from the posterior aspect of the artery and ascends through the foramina in the transverse processes of the cervical vertebræ—entering usually at the sixth and, winding backward around the superior articular process of the atlas, enters the cavity of the cranium through the foramen magnum and unites, at the lower border of the pons Varolii, with its fellow of the opposite side to form a single trunk called the basilar artery, which runs forward to the anterior border of the pons where it divides into four terminal branches, two to each side. It gives off the following branches:

1st. Lateral spinal, which are given off as the artery ascends the neck and enter the inter-vertebral foramina.

2d. Muscular, unimportant branches to cervical muscles.

3d. Posterior meningeal, also an unimportant branch to the dura mater of the cranium.

4th. Anterior spinal, which unites with its fellow of the opposite side to form a common trunk which descends from the cranium along the front of the spinal cord.

5th. Posterior spinal, which winds around the medulla oblongata to descend on the posterior aspect of the spinal cord.

6th. Inferior cerebellar, which winds around the medulla oblongata to reach the under surface of the cerebellum.

The branches of the basilar artery are as follows:

1st. Transverse, which are numerous branches given off to each side of the pons Varolii.

2d. Anterior cerebellar, which runs along the anterior border of the cerebellum and may be given as one of the transverse.

The two terminal branches to each side are:

3d. Superior cerebellar, which is distributed to the upper surface of the cerebellum.

4th. Posterior cerebral, which is distributed to the posterior lobes of the cerebrum.

Just as the basilar artery divides it gives off numerous small branches which enter the minute foramina constituting the locus perforatus of the base of the brain.

II. Inferior Thyroid.

The inferior thyroid is the most constant branch of the thyroid axis, which arises from the upper aspect of the subclavian near the termination of its first portion.

The inferior thyroid first ascends and then turns inward behind the sheath of the common carotid artery to reach the thyroid gland. Its branches are some unimportant twigs to the larynx, trachea and œsophagus and a large branch called the cervicalis ascendens, which arises from the inferior thyroid just as it makes its inward turn and ascends the neck on the anterior tubercles of the transverse processes to be distributed to muscles and glands.

III. Supra-Scapular.

The supra-scapular artery arises, usually, from the thyroid axis. It first descends and then turns outward behind the clavicle and, crossing the third portion of the subclavian, passes across the transverse ligament of the scapula to the dorsum of the scapula to be distributed there.

IV. Transversa Colli.

The transversa colli arises, usually, from the thyroid axis. It passes outward across the side of the neck to the anterior edge of the trapezius muscle where it divides into two branches, viz: the cervicalis superficialis, which ascends beneath the trapezius, and the posterior scapular, which passes to the scapula and descends along its base.

V. Internal Mammary.

The internal mammary arises from the under aspect of the subclavian and descending behind the costal cartilages, about half an inch from the edge of the sternum, to the diaphragm divides into two terminal branches, superior epigastric and musculo-phrenic. Its branches are as follows:

1st. Anterior intercostal, which are given off to the intercostal spaces over which the internal mammary passes. Each, passing outward, soon divides into two branches to course along the adjacent borders of the ribs. Sometimes these branches spring separately from the artery.

2d. Perforating, which—generally six in number—pass forward to the front of the thorax and run outward, being chiefly distributed to the mammary gland in the female.

3d. Mediastinal, which are unimportant branches to the anterior mediastinum.

4th. Pericardiac, which are unimportant branches to the pericardium.

5th. Comes nervi phrenici, which is a small branch to accompany the phrenic nerve.

6th. Musculo-phrenic, one of the terminal branches, which passes outward and downward to the last intercostal space, behind the cartilages of the false ribs.

7th. Superior epigastric, the other terminal branch, which enters the sheath of the rectus abdominis muscle and there anastomoses with the inferior epigastric, a branch which springs from the external iliac. This is the longest arterial anastomosis in the body and, taken in connection with the number of branches produced by the internal mammary, renders that artery the most remarkable in the body.

VI. Superior Intercostal.

The superior intercostal usually springs by a common trunk with the cervicalis profunda from the second portion of the subclavian artery. It descends in front of the neck of the first rib and gives off branches to the first two intercostal spaces.

VII. Cervicalis Profunda.

The cervicalis profunda artery passes backward between the transverse processes of the seventh cervical vertebra and the first rib or transverse process of the first dorsal vertebra, and ascends the neck to inosculate with the princeps cervicis branch of the occipital artery, thus establishing collateral circulation in ligation of the common carotid.

The Axillary Artery.

The axillary is the second subdivision of the artery of the upper extremity. Beginning where the subclavian ceases at the outer border of the first rib, it passes downward and outward over the upper lateral aspect of the chest (the first four ribs) and down the inner aspect of the arm to terminate at the lower edge of the tendons of the latissimus dorsi and teres major muscles by becoming the brachial artery. The direction of that part of the artery on the arm varies of course with the movement of the limb.

Relations.

It is covered throughout by the pectoralis major and beneath this it is crossed by the pectoralis minor. The latter relation warrants the subdivision of the artery into three portions. The first portion extends from the commencement of the artery to the upper edge of the pectoralis minor muscle, being contained in the triangular space between that muscle and the clavicle; the second lies beneath the pectoralis minor; the third extends from the lower edge of the pectoralis minor to the termination of the artery. As the artery is crossing from the chest to the arm it lies on the tendon of the subscapularis and as soon as it strikes the inner side of the arm it lies along the inner side of the coraco-brachialis, which relation it maintains to its termination.

The first portion of the axillary has the brachial plexus of nerves to its outer side and is covered by the pectoralis major.

The second portion has the three cords which here make up the plexus one to its outer, one to its inner side and one behind it. It is covered in front by both the pectoral muscles and behind lies on the subscapularis.

In the third portion the inner and outer cords each gives off a branch, the two uniting over the front of the artery to form the median nerve, which immediately drops off to the outer side of the artery where it remains to the termination of the vessel. This portion of the artery is covered in front only by the pectoralis major, while behind it lies on the tendons of the latissimus dorsi and teres major. Throughout the course of the artery the axillary vein lies continuously to its inner front aspect.

Branches.

SHORT THORACIC.
ACROMIAL THORACIC.
THORACICA ALARIS.
LONG THORACIC.
POSTERIOR CIRCUMFLEX.
ANTERIOR CIRCUMFLEX.
SUBSCAPULAR.

The first two usually arise from the first portion of the axillary, the next two from the second portion, and the last three from the third portion.

I. Short Thoracic.

The short, or superior, thoracic arises from the first portion of the axillary and passes inward on the pectoralis minor muscle to be distributed to the pectoral muscles and mammary gland.

II. Acromial Thoracic.

The acromial thoracic arises from the first portion of the axillary by a short trunk which divides into the three following branches.

1st. Pectoral, which supplies the pectoral muscles.

2d. Acromial, which gives its name to the trunk though the smallest of its progeny, and passes outward to be distributed to parts around the acromion process.

3d. Descending, which descends in the interspace between the deltoid and pectoralis major muscles.

III. Thoracica Alaris.

The thoracica alaris is a small branch given off from the second portion of the axillary to structures in the axilla.

IV. Long Thoracic.

The long thoracic artery arises from the second portion of the axillary and descends to supply the chest wall. It passes between the pectoral muscles and the serratus magnus and supplies both.

V. Anterior Circumflex.

The anterior circumflex artery arises from the third portion of the axillary, passes outward on the front of the humerus just below the shoulder joint, to which it is distributed, anostomosing externally with the posterior circumflex.

VI. Posterior Circumflex.

The posterior circumflex artery springs from the third portion of the axillary, runs outward on the back of the humerus, is distributed to the shoulder joint and neighboring structures and inosculates with the anterior circumflex, the two forming a vascular zone around the upper extremity of the humerus. The posterior is much the larger of the two.

VII. Subscapular.

The subscapular artery arises from the third portion of the axillary, and descends along the lower border of the subscapularis muscle to be

distributed to adjacent parts. About an inch and a half from its origin it gives off a branch, the dorsalis scapulæ, which mounts upon the dorsum of the scapular, to be there distributed.

Brachial Artery.

The brachial is the third subdivision of the artery of the upper extremity. It begins by being a continuation of the axillary at the lower border of the tendons of the latissimus dorsi and teres major and passing downward and outward terminates half an inch, or a finger's breadth, below the middle of the front of the elbow-joint by dividing into the ulnar and radial arteries. It lies first on the inner side of the arm and then on the front; so that in order to check the circulation by pressure, in the first part of its course the force must be directed outward and in the second part directly backward.

Relations.

The muscular relations are as follows: To its outer side, at first, is the lower half of the coraco-brachialis and when this relation is lost by the insertion of the muscle, its place is taken by the biceps, whose belly, when the muscle is bulky, overlaps the artery. At the bend of the elbow it lies beneath the slip given off by the biceps. In the first part of its course it lies on the internal intermuscular septum and in the lower part on the brachialis anticus.

Its relations to cords are as follows:

It is accompanied by satellite veins, one on either side, the one on the inner side being the larger.

To its inner side are the basilic vein and the internal cutaneous nerve.

The median nerve lies first to the outer side of the artery, then crosses it, usually in front, about the middle of the arm and remains a continuous internal relation. The internal cutaneous nerve and the basilic vein are superficial to the artery in the lower part of its course, lying between the layers of superficial fascia, while the artery lies beneath the deep fascia.

Brachial at the Elbow.

These relations are of such importance that they must be given separately. It lies on the middle of the front of the joint with a satellite vein on either side. On its outer side is the tendon of the biceps muscle; on its inner side the median nerve. In front of it is the bicipital fascia and

lying on this are the median basilic vein and the internal cutaneous nerve.

The brachial artery, once in five times, divides before reaching the point stated in this description. This is called high or premature division. When this is the case the ulnar artery continues the course of the brachial while the radial descends superficial to the ulnar.

Branches.

The branches are three in number, besides numerous twigs to muscles in its course collectively called muscular branches.

I. Superior Profunda.

The superior profunda arises from the upper part of the brachial and passes downward and outward, winding around the humerus, in the groove on its posterior face, to reach the outer aspect of the elbow joint where it lies in the interval between the supinator longus and the brachialis anticus muscles.

II. Inferior Profunda.

The inferior profunda artery arises from the brachial just below the superior and descends to the inner side of the elbow joint.

III. Anastomotica Magna.

The anastomotica magna runs inward from the brachial about two inches above the elbow and then runs outward on the back of the arm to the external condyle.

Arteries of the Forearm.

The arteries of the forearm are the radial and ulnar and their branches.

Radial Artery on the Forearm.

The radial artery, one of the two terminal branches of the brachial, begins where that artery divides about half an inch below the middle of the front of the elbow, and passes downward with such an inclination outward as to bring it to the outer side of the front of the wrist joint, where it lies on the front of the styloid process of the radius, terminating as the radial artery of the forearm by becoming the radial artery of the wrist.

Relations.

To the outer side it has throughout its course the supinator longus, whose belly overlaps it. With this exception the artery is superficial. To its inner side is first the pronator radii teres, and, when that muscle is inserted, its place is taken by the flexor carpi radialis which remains to the inner side.

It is accompanied by satellite veins, one on either side, and in the middle third of its course has the radial nerve to its outer side. The nerve in the upper third is too far away to be considered a relation, while in the lower third it passes beneath the tendon of the supinator longus and disappears on the back of the forearm.

Ulnar Artery on the Forearm.

The ulnar artery, the larger of the two terminal branches of the brachial, begins where that artery terminates about half an inch below the middle of the front of the elbow, by dividing into itself and the radial, and passes first downward and inward for the upper third of its course, to the inner side of the front of the forearm and then turns vertically downward to reach the inner side of the front of the wrist, where it terminates as the ulnar artery of the forearm by becoming the ulnar artery of the hand.

Relations.

In the first part of its course, while it is passing downward and inward, it lies beneath four muscles, viz: pronator radii teres, flexor carpi radialis, palmaris longus and flexor sublimis digitorum—all the muscles of the superficial group except the flexor carpi ulnaris. When it emerges from beneath these muscles it descends with the tendon of the flexor carpi ulnaris to its inner and of the flexor sublimis digitorum to its outer side.

It is accompanied by satellite veins, one to either side, and for its lower two-thirds has to its inner side the ulnar nerve.

Ulnar Artery in the Hand.

When the ulnar artery reaches the wrist it continues its course into the palm of the hand, lying close to and on the outer side of the pisiform bone and *on* the anterior annular ligament. After passing down a short distance into the palm, it turns outward and runs across the palm of the hand to its outer side, being covered only by the skin and fascia and

lying on the flexor tendons. Its course across the palm is known as the superficial palmar arch (arcus sublimis) and though its direction is not transverse, it is more or less clearly defined by a transverse line across the palm drawn from the bottom of the internal between the thumb and index finger. The ulnar nerve continues its relation to the artery in the hand, lying to its inner side.

Branches.

ANTERIOR ULNAR RECURRENT.	INTEROSSEOUS.
POSTERIOR ULNAR RECURRENT.	MUSCULAR.

I. Anterior Ulnar Recurrent.

The anterior ulnar recurrent arises from the ulnar just below its origin and passes upward to the front of the inner side of the elbow.

II. Posterior Ulnar Recurrent.

The posterior ulnar recurrent rises just below the preceding and passes upward and backward to the internal condyle.

III. Interosseous.

The interosseous is a large trunk which arises from the ulnar just below the elbow and quickly forks into an anterior and posterior interosseous.

1st. The anterior interosseous descends on the front of the interosseous membrane, between the flexor profundus digitorum and flexor longus pollicis muscles, to the pronator quadratus, passing beneath which it perforates the interosseous membrane and appear on the back of the forearm to inosculate with the posterior interosseous artery. It supplies the muscles in its route and gives off a companion branch to the median nerve.

2d. The posterior interosseous, as soon as it is produced, passes between the bones above the interosseous membrane, to reach the back of the forearm and descend on the back of the interosseous membrane to the wrist. Just as it reaches the back of the forearm it gives off a large branch, called the posterior interosseous recurrent, which ascends to the back of the elbow.

The posterior interosseous artery is distributed to adjacent muscles.

IV. Muscular.

The muscular branches of the ulnar artery are numerous twigs to muscles in its course.

Branches at the Wrist.

ANTERIOR CARPAL. POSTERIOR CARPAL.

I. Anterior Carpal.

The anterior carpal is a branch which passes outward on the front of the wrist to inosculate with the anterior carpal of the radial.

II. Posterior Carpal.

The posterior carpal passes backward and then runs outward on the back of the wrist to anastomose with the posterior carpal of the radial.

These branches are very small and the anterior is frequently absent.

Branches in the Hand.

COMMUNICATING. DIGITAL.

I. Communicating.

The communicating branch dips between the abductor minimi digiti and flexor brevis minimi digiti to join the termination of the radial.

II. Digital.

The thumb and each of the fingers have two palmar arteries, one on either side, and two dorsal, similarly arranged, running from base to tip, called respectively palmar and dorsal collateral digital arteries. The digital arteries now under consideration are four in number, from the superficial palmar arch. The first is a small branch which supplies the inner side of the little finger; the second supplies adjacent sides of the little and ring fingers, splitting at the cleft between the two; the third does the same for adjacent sides of the middle and ring fingers and the fourth for adjacent sides of the middle and index fingers.

Radial Artery of Wrist and Hand.

When the radial artery reaches the wrist it turns outward, backward and downward beneath the extensor tendons of the thumb, viz: the extensor ossis metacarpi pollicis, extensor primi and extensor secondi intermodii pollicis, in the order named, and passing through what is known as the snuff box—the sunken interval between the extensor ossis metacarpi pollicis and extensor primi internodii pollicis on one side and the extensor secundi internodii pollicis on the other—reaches the back of the hand where its appearance is only momentary, for it immediately dips into the palm of the hand by passing between the two heads of the first dorsal interosseous muscles, and, passing across the palm of the hand from the outer to the inner side, terminates by anastomosing with the communicating branch from the superficial palmar arch. The position of the radial in the palm is deep, lying on the bases of the metacarpal bones and beneath the flexor tendons which separate it from the superficial palmar arch. It is called the deep palmar arch and is situated about half an inch nearer the wrist than the superficial arch.

Branches of the Forearm.

RECURRENT RADIAL. MUSCULAR.

I. Recurrent Radial.

The recurrent radial arises from the radial just below the elbow and passes upward and outward to the outer side of the front of the joint.

II. Muscular.

The muscular branches are numerous twigs to muscles in the course of the artery.

Branches at the Wrist.

SUPERFICIALIS VOLÆ. DORSALIS POLLICIS.
ANTERIOR CARPAL. METACARPEA.
POSTERIOR CARPAL. DORSALIS INDICIS.
PRINCEPS POLLICIS.

I. Superficialis Volæ.

The superficial volæ leaves the radial just as it turns outward and

passes to the muscles of the thenar group, usually perforating the abductor pollicis.

II. Anterior Carpal.

The anterior carpal branch passes inward on the front of the joint to form the anterior carpal arch by uniting with the anterior carpal of the ulnar artery.

III. Posterior Carpal.

The posterior carpal passes inward across the back of the wrist to inosculate with the posterior carpal of the ulnar and form the posterior carpal arch. From the posterior carpal arch there pass down on the dorsal interosseous muscle two branches called posterior interosseous besides another which runs along the dorsal aspect of the ulnar border of the hand to supply the ulnar side of the dorsal aspect of the little finger. The posterior interosseous pass downward to divide the one at the cleft between the little and ring fingers to form dorsal collateral digital branches for the adjacent sides of those fingers, while the other performs a similar duty for the adjacent sides of the ring and middle fingers.

IV. Dorsalis Pollicis.

Just as the radial is passing the root of the thumb it gives off two small branches which course along the sides of the dorsal aspect of the thumb. They are called dorsalis pollicis.

V. Metacarpea.

The metacarpea is a branch which descends on the second dorsal interosseous muscle to the cleft between the middle and index fingers and there divides to form dorsal collateral digital branches for those fingers.

VI. Dorsalis Indicis.

The dorsalis indicis is a small branch which passes forward to form the dorsal collateral digital branch for the outer side of the index finger.

VII. Princeps Pollicis.

The princeps pollicis arises just as the radial dips into the palm of the hand and passes forward and outward to divide and form collateral digital arteries for the palmar aspect of the thumb.

Branches of the Deep Palmar Arch.

RADIALIS INDICIS. ANTERIOR INTEROSSEOUS.

I. Radialis Indicis.

The radialis indicis passes forward to form the collateral digital branch for the palmar aspect of the index finger.

II. Anterior Interosseous.

The anterior interosseous are three or four small branches which pass forward on the front of the interosseous muscles to unite with the digital branches of the superficial arch.

Besides these the deep arch gives off two sets of unimportant branches called perforating and recurrent.

The Left Subclavian Artery.

The left subclavian artery differs from the right in its first portion only, which extends from its origin to the inner edge of the scalenus anticus muscles. It arises as the last of the three branches from the arch of the aorta and passes almost perpendicularly to the inner edge of the scalenus anticus muscle and turns suddenly outward behind that muscle to pursue a course corresponding to that of the artery of the opposite side.

Relations.

In front of it is the confluence of the left internal jugular and left subclavian veins to form the left vena innominata; and the left pneumogastric and left phrenic nerves descend on its front into the thorax. To its inner side are the left common carotid artery and the trachea. Behind it is the thoracic duct. The pleura almost surrounds the artery, being in contact with it in front, behind and to the outer side.

Branches of the Thoracic Aorta.

BRONCHIAL. INTERCOSTAL.
MEDIASTINAL. PERICARDIAC.
ŒSOPHAGEAL.

I. Bronchial.

The bronchial arteries, usually three to the left lung and one to the

right, course along the bronchi to the lungs and ramify with the bronchial tubes.

II. Intercostal.

The intercostal are ten pairs of arteries which arise from both sides of the thoracic aorta and run out in the intercostal spaces, the upper intercostal space being supplied by the superior intercostal of the subclavian.

Each intercostal artery passes outward in the intercostal space to run along the lower border of the rib above and, after going some distance, give off a branch, which sinks to course along the upper border of the rib below. The intercostal arteries for the right side are longer than those of the left, owing to the position of the aorta which forces them to cross the vertebral column.

These branches of the thoracic aorta are sometimes known as the posterior intercostal arteries to distinguish them from the anterior intercostals of the internal mammary and the superior of the subclavian.

III. Œsophageal.

The œsophageal are four or five small twigs which are successively furnished the œsophagus.

IV and V. Mediastinal and Pericardiac.

These are small branches furnished to the posterior mediastinum and to the pericardium respectively.

Branches of the Abdominal Aorta.

The branches of the abdominal aorta are nine in number, arranged in three sets, viz: those distributed to the abdominal wall and called parietal branches; those distributed to the abdominal viscera—the organs of digestion and those accessory thereto—and those distributed to the genito-urinary organs. There are three arteries in each of these sets, but some are double, *i. e.*, one on each side.

Parietal Branches.

PHRENIC. SACRA MEDIA. LUMBAR.

I. Phrenic Arteries.

The phrenic are a pair of small arteries arising from the aorta soon

after it enters the abdomen, sometimes singly, sometimes by a common trunk and sometimes from neighboring arteries. Each artery runs upward and outward on the under surface of the diaphragm and is there distributed by two branches, one passing inward to inosculate over the œsophageal opening with the opposite one, while the other runs outward to supply the circumference of the diaphragm.

II. Lumbar Arteries.

The lumbar arteries are four or five pairs of small branches which spring successively from the back of the aorta and run outward to ramify in the broad muscles of the abdomen, resembling the intercostal branches of the thoracic aorta.

III. Sacra Media.

The sacra media is a small slender artery which arises just at the foot of the aorta, or sometimes from one of its fork, and runs down on the front of the sacrum to the coccyx.

Visceral Branches.

CŒLIAC AXIS. SUPERIOR MESENTERIC.
INFERIOR MESENTERIC.

Cœliac Axis.

The cœliac axis is a short trunk about one-half an inch in length, which arises from the front of the abdominal aorta near its commencement. It runs directly forward from the front of the abdominal aorta. Below it is the head of the pancreas upon which it rests; in front is the lesser omentum; above and to the right is the lobus Spigelii. The semilunar ganglia lie upon its sides, while the solar plexus of nerves surround the artery. Its branches are three, gastric, splenic, and hepatic.

1. The Gastric Artery.

The gastric artery passes to the left to reach the cardiac end of the stomach and then turns to the right to run along the lesser curvature to near the pylorus where it inosculates with the pyloric branch of the hepatic artery. It distributes branches to both sides of the stomach.

2. The Splenic Artery.

The splenic artery passes tortuously to the left along the upper border of the pancreas to the hilum of the spleen where it splits into numerous branches to be distributed to that organ. Its branches are as follows:

(*a*) Pancreatic, numerous small branches which descend into the pancreas as the splenic artery is coursing along its upper border.

(*b*) Vasa brevia, five or six branches which leave the splenic artery near its terminal branches and pass to the splenic end of the stomach.

(*c*) Gastro-epiploica sinistra, the left gastro-epiploic, a large branch which leaves the splenic artery near the spleen and runs to the right along the greater curvature of the stomach until it meets the right gastro-epiploic about the middle of that curvature. It gives off ascending branches to both faces of the stomach and descending branches to the great omentum.

3. The Hepatic Artery.

The hepatic is a large branch which passes upward and to the right to the under surface of the liver where it divides into three branches, one to each lobe of the liver and a third called the cystic which is distributed to the coats of the gall-bladder. Besides its three terminal branches the hepatic artery produces two others.

(*a*) The pyloric branch passes to the left along the lesser curvature of the stomach until it meets the gastric artery, being distributed to both faces of the stomach.

(*b*) The gastro duodenalis is a large branch which descends from the hepatic behind the pancreas and divides into two branches.

1st. Pancreatico-duodenalis superior which descends between the pancreas and duodenum and is there distributed.

2d. Gastro-epiploica dextra, which passes to the left along the greater curvature of the stomach to meet the gastro-epiploica sinistra, a branch of the splenic.

II. Superior Mesenteric Artery.

The superior mesenteric is a large artery which arises from the front of the aorta just below the cœliac axis and behind the head of the pancreas. It descends between the lower border of the pancreas and the transverse duodenum to reach the right iliac fossa, presenting in its course a curve whose convexity is to the left, and lying between the layers of the mesentery.

Branches.

Besides a small branch called pancreatico-duodenalis inferior, which ascends between the head of the pancreas and the duodenum, the branches of the superior mesenteric are as follows:

1. Vasa Intestini Tenuis.

Arising successively from the convex aspect of the superior mesenteric artery are fifteen or twenty branches which are distributed to the small intestine from the duodenum to near the ileo-cœcal aperture. They are called vasa intestini tenuis. After running a short distance these branches divide and unite with adjacent ones, forming arches from which spring other branches which in turn unite to form a second series of arches; and from these spring another set of branches which form the third series of arches from which straight vessels pass out to supply both faces of the gut.

2. Ileo-Colic Artery.

The ileo-colic is the lowest of the three branches given off from the concave aspect of the superior mesenteric and is distributed to the termination of the ileum and beginning of the large intestine.

3. Colica Dextra.

The colica dextra is the middle of the three branches arising from the right side of the superior mesenteric and is distributed to the ascending colon.

4. Colica Media.

The colica media is the first of the three arteries which arise from the right aspect of the superior mesenteric. It turns upward and is distributed to the right half of the transverse colon and to the termination of the ascending colon. All these branches of the superior mesenteric anastomose with each other successively in the order in which they are given off, and the colica media anastomose with the colica sinistra branch of the inferior mesenteric.

III. Inferior Mesentric.

The inferior mesenteric, smaller than the superior, arises from the front of the aorta near its termination and descends obliquely to the left iliac fossa, giving off the following branches:

1. Colica Sinistra.

The colica sinistra passes downward and to the left, and divides into two branches, one of which is distributed to the descending colon, while the other ascends to supply the left half of the transverse colon and inosculate with the colica media branch of the superior mesenteric.

2. Sigmoideal.

The sigmoideal are several branches distributed to the sigmoid flexure of the colon.

3. Superior Hemorrhoidal.

The superior hemorrhoidal is the continuation of the inferior mesenteric. It descends along the posterior aspect of the rectum to about its middle, where it divides, being distributed to the rectum.

The branches of the inferior mesenteric anastomose with each other and its colica sinistra branch anastomoses with the colica media of the superior mesenteric.

SUMMARY.

The stomach is supplied with blood by the following arteries: the lesser curvature by the gastric artery and the pyloric branch of the hepatic; the greater curvature by the right gastro-epiploic for its right half and the left gastro-epiploic for its left half; the former being a branch of the gastro-duodenalis, a branch of the hepatic, and the latter a branch of the splenic. The splenic end of the stomach is supplied by the vasa brevia of the splenic artery.

The duodenum is chiefly supplied by the pancreatico-duodenalis superior branch of the gastro-duodenalis of the hepatic.

The small intestine, from the duodenum to near the large intestine, is supplied by the vasa intestini tenuis of the superior mesenteric. The termination of the small intestine and the commencement of the large are supplied by the ileo-colic branch of the superior mesenteric. The ascending colon is supplied by the colica dextra, and the right half of the transverse colon by the colica media branch of the same artery. The left half of the transverse colon and the descending colon are supplied by the colica sinistra of the inferior mesenteric. The sigmoid flexure is supplied by the sigmoidal branches, and the upper half of the rectum by the superior hemorrhoidal branch from the inferior mesenteric.

Genito-Urinary Branches.

SPERMATIC. RENAL.
SUPRA-RENAL.

Spermatic Arteries.

The spermatic are a pair of small arteries which arise from the front of the aorta and descend behind the peritoneum to the brim of the pelvis, one on each side. In the male the artery passes then to the internal abdominal ring, and accompanies the other elements of the cord to the testicle. In the female this artery is known as the ovarian, and is expended on the ovaries and Fallopian tubes.

Renal Arteries.

Each renal artery arises from the side of the aorta and passes outward to be distributed to the kidney. The left renal artery is somewhat higher than the right owing to the relative position of the two kidneys.

Supra-Renal Arteries.

The supra-renal are a pair of small arteries which arise from the side of the aorta about the origin of the renal arteries and pass out, one on either side, to be distributed to the supra-renal capsule.

Common Iliac Arteries.

The common, or primitive, iliac artery of each side begins where the abdominal aorta bifurcates at the left side of the lower border of the body of the fourth lumbar vertebra, as a rule, though the exact point of division may vary as much as an inch. From this point the common iliac passes downward and outward to the brim of the pelvis, where it terminates on the side of the disk between the fifth lumbar vertebra and the sacrum by dividing into the external and internal iliac arteries. The right artery is slightly the longer, the average length of each being about two inches.

Relations Right Common Iliac.

The right common iliac is crossed in front, near its termination, by the right ureter. To its outer side is the psoas magnus muscle. Behind and

somewhat external is the right common iliac vein and crossing behind it is the left common iliac vein.

Relations Left Common Iliac.

The left common iliac is crossed in front by the sigmoid flexure of the colon, by the superior hemorrhoidal artery and by the left ureter, near its termination. External to it is the psoas magnus muscle. Its vein is behind and internal to it. It is thus seen that each vein is more or less to the right of its artery and behind, the left vein being forced to cross behind the right artery in order to unite with the right vein to form the inferior vena cava, which lies to the right of the aorta.

Internal Iliac Artery.

The internal iliac artery, one of the two terminal branches of the common iliac, begins where that artery forks, on the brim of the pelvis on the disk between the fifth lumbar vertebra and the sacrum and descends into the pelvis on the front of the sacro-iliac symphysis to the upper margin of the great sacro-sciatic notch, and there divides into an anterior and a posterior trunk. The artery varies in length from an inch to two inches. The only relation besides those given is that the vein is immediately behind it.

The distribution of the internal iliac is to the viscera and walls of the pelvis; and it will be found, with trifling exceptions, that the parietal branches spring from the posterior trunk while the visceral are the offspring of the anterior. It should be remembered that the hypogastric artery of the fœtus is a branch of the internal iliac; passing from it upward and inward to the bladder and up beside it to reach the umbilicus after coursing along the posterior aspect of the anterior abdominal wall, and that after birth it is impervious from the umbilicus as far back as the side of the bladder, but from this point to its origin it remains open and gives origin to some arteries which supply the bladder, viz: those which supply its upper and middle portions, called the superior and middle vesical arteries.

Branches of the Anterior Trunk.

HYPOGASTRIC.
INFERIOR VESICAL.
MIDDLE HEMORRHOIDAL.
OBTURATOR.
ISCHIATIC.
INTERNAL PUDIC.

Inferior Vesical.

The inferior vesical is distributed to the base of the bladder and, in the male, also to the prostate gland and seminal vesicles.

Middle Hemorrhoidal.

The middle Hemorrhoidal artery aids in supplying the rectum and derives its name from the fact that there are two other hemorrhoidal arteries, one supplying the upper and one the lower part of the gut, while this takes the intermediate portion.

Besides these two branches, there are some peculiar to the female, viz: vaginal, to supply the vagina, and uterine to the uterus.

Obturator.

The obturator artery passes forward along the wall of the pelvis just below the brim and escapes through the upper part of the obturator foramen to divide into an internal and an external branch which are distributed around the front of the obturator foramen. The obturator artery is frequently a branch from the posterior trunk, and once in three dissections will be found descending to the obturator foramen from the epigastric branch of the external iliac.

After giving off the foregoing branches the anterior trunk divides into two branches, the ischiatic or sciatic and the internal pudic.

Ischiatic Artery.

The ischiatic artery, one of the two terminal branches of the anterior trunk of the internal iliac, leaves the pelvis through the greater sacrosciatic foramen *below* the pyriformis muscle and descending between the trochanter major and the tuberosity of the ischium breaks into numerous branches, most of which are muscular.

Internal Pudic.

The internal pudic artery, the second of the two terminal branches of

the anterior trunk of the internal iliac, leaves the pelvis through the greater sacro-sciatic foramen below the pyriformis muscle, and passing across the spine of the ischium re-enters the pelvis through the lesser sacro-sciatic foramen and runs forward and upward about an inch above the lower edge of the tuber ischii, and then along the inner aspect of the rami of the ischium and pubes towards the symphysis pubis.

Branches.

Inferior Hemorrhoidal.

The inferior hemorrhoidal are several small branches given to the anus as the internal pudic is passing near it.

Superficial Perineal.

The superficial perineal passes forward through the perineum as far as the scrotum and in its course gives off the transversus perinæi branch which crosses the perineum.

The Artery of the Bulb.

The artery of the bulb enters the bulb of the corpus spongiosum and is there distributed.

Artery of the Corpus Cavernosum.

The artery of the corpus cavernosum enters the crus penis and is distributed to the corpus cavernosum.

Dorsal Artery of the Penis.

The dorsal artery of the penis runs along the dorsum of the penis as far as the glans.

Branches of the Posterior Trunk.

LATERAL SACRAL. GLUTEAL. ILIO-LUMBAR.

Lateral Sacral Arteries.

The lateral sacral are a pair of small arteries the superior of which enters the first anterior sacral foramen and the inferior passes down on the side of the front of the sacrum and sends a branch into each anterior sacral foramen except the first.

Ilio-Lumbar Artery.

The ilio-lumbar is a recurrent branch which ascends beneath the external iliac artery and divides into two branches, one of which continues upward to the psoas magnus and quadratus lumborum muscles, while the other turns outward.

Gluteal Artery.

The gluteal artery is the continuation of the posterior trunk of the internal iliac. It passes backward through the upper part of the great sacro-sciatic foramen *above* the pyriformis muscle and divides into three branches, a superficial which is distributed between the gluteus maximus and gluteus medius muscles and two deep branches which lie between the gluteus medius and minimus.

External Iliac Artery.

The external iliac begins where the common iliac forks into it and the internal iliac on the side of the disk between the fifth lumbar vertebra and the sacrum and continues the course of its parent downward and outward to enter the thigh and become the femoral artery by passing beneath Poupart's ligament at a point midway between the anterior superior spinous process of the ilium and the symphysis pubis. Its course and that of the common iliac may be indicated by drawing a line from a point just to the left of the umbilicus, which corresponds to the bifurcation of the aorta, downward to a point half way between the anterior superior spinous process of the ilium and the symphysis pubis.

Relations.

To the outer side of the artery is the psoas magnus muscle separated from it by the iliac fascia which throws a covering over them. In front is the peritoneum and some fascia. Each artery is accompanied by a vein, the relation to which is different on the two sides. The vein of the left side is internal throughout; that of the right is first behind and external, then behind and then internal and abreast, so that at Poupart's ligament each vein is internal to and fully abreast of its artery.

Branches.

EPIGASTRIC. CIRCUMFLEX ILIAC.

Epigastric Artery.

The epigastric artery arises from the inner side of the external iliac near Poupart's ligament and runs upward and inward on the posterior face of the anterior abdominal wall, lying just beneath the peritoneum and transversalis fascia, which it raises into a ridge and enters the sheath of the rectus muscle, where it anastomoses with the inferior epigastric branch of the internal mammary, thus forming the most remarkable anastomosis in the body. Soon after its origin the epigastric artery gives off a communicating branch which descends to the obturator artery, and, indeed, sometimes supplies the place of that artery.

Circumflex Iliac Artery.

The circumflex iliac arises from the outer side of the external iliac just above Poupart's ligament and passes upward and outward along the crest of the ilium and about the middle of it gives off a large branch which is distributed between the internal oblique and transversalis muscles.

The Femoral Artery.

The femoral artery is the continuation of the external iliac, commencing where that artery terminates, beneath Poupart's ligament, at a point midway between the anterior superior spinous process of the ilium and the symphysis pubis, where it can be felt pulsating, it descends the front of the thigh to its lower third, where it pierces the insertion of the adductor magnus muscle to reach the back of the thigh and become the popliteal. As long as it lies on the front of the thigh, that is, for the upper two-thirds of its course, it is known as the femoral artery; as soon as it reaches the lower third and appears on the back of the thigh it is called popliteal.

A line drawn from about the middle of Poupart's ligament to the inner aspect of the internal condyle will indicate the course of the femoral artery, which lies behind the upper two-thirds of the line.

Relations.

For the first half or third of its course the femoral artery is superficial,

lying in Scarpa's triangle, having the sartorius to its outer side and the adductor longus to its inner side. It enters the triangle about the middle of the base and passing through the centre leaves it usually about at its apex by passing beneath the sartorius. It then descends, lying on the front of the insertion of the adductor longus, which relation it maintains to within about an inch or so of its termination, and for that distance it is separated from the posterior face of the sartorius by a tendinous arch which the adductor longus and adductor magnus throw over the artery to the vastus internus; so that the last inch or two of the femoral artery is the deepest portion, being covered by the skin, superficial fascia, fascia lata, sartorius and the tendinous arch above mentioned. Throughout its course the artery lies between the sartorius and adductor longus.

In the upper part of its course these muscles lie one on either side, while below the sartorius is in front and the adductor longus behind. For the last inch or two the sartorius is separated from the artery by the tendinous arch.

Relation to cords: It lies in a sheath which also contains the femoral vein. At Poupart's ligament the vein is *internal* and *abreast* of the artery, but as it descends it gradually gets *behind* the artery and then *external*. For the first few inches of its course the artery has from one-fourth to one-half an inch to its outer side the anterior crural nerve which here divides into numerous branches, some of which cross in front of the artery, while one, the long saphenous, descends to its outer side until it reaches Hunter's canal when it gets in front. It is not in the sheath of the artery. From one to two inches below Poupart's ligament the artery gives off a large branch, the deep femoral. At first this branch is external to the femoral, but it quickly passes behind, remaining a posterior relation until they are separated by the adductor longus muscle. Between the two arteries are interposed the corresponding veins, the femoral vein being in front.

Branches.

SUPERFICIAL EPIGASTRIC.	DEEP EXTERNAL PUDIC.
SUPERFICIAL CIRCUMFLEX ILIAC.	PROFUNDA FEMORIS.
SUPERFICIAL EXTERNAL PUDIC.	ANASTOMOTIC MAGNA.

MUSCULAR.

Soon after its commencement the femoral artery gives off four small branches which are all cutaneous. They are the first four named above.

Superficial Epigastric.

The superficial epigastric passes upward and inward toward the umbilicus lying beneath the skin and superficial fascia.

Superficial Circumflex Iliac.

The superficial circumflex iliac runs upward and outward along the crest of the ilium.

Superficial External Pudic.

The superficial external pudic passes inward in front of the femoral vein towards the genital organs.

Deep External Pudic.

The deep external pudic runs inward behind the femoral vein to be distributed to the integument of the external organs of generation.

Profunda Femoris.

At a variable distance from its commencement, generally from one to two inches though sometimes less and sometimes more, the femoral artery gives off from its outer posterior aspect a branch called the profunda femoris which is almost as large as the continuation of the femoral itself. The direction of the profunda is for a short distance downward and outward, then curving inward, almost immediately after its origin, it descends vertically lying behind the femoral artery and having no muscle interposed between them until the two reach the upper edge of the adductor longus which muscle thence forward separates them, the femoral passing down on its front and the profunda behind it for some distance and then, perforating the adductor magnus, passes to the back of the thigh where it is distributed.

The profunda artery is contained in a sheath in which lies also its vein, which is in front of the artery. As the profunda descends behind the femoral it is separated from it by two veins, profunda and femoral; so that from the origin of the profunda down to the adductor longus muscle, the structures lie in the following order from before backward: femoral artery, femoral vein, profunda vein, profunda artery.

Branches of the Profunda.

EXTERNAL CIRCUMFLEX. INTERNAL CIRCUMFLEX.
THREE PERFORATING.

External Circumflex.

The external circumflex arises early from the profunda and passes outward around the upper extremity of the femur, giving off two sets of branches, one ascending to the gluteal region and the other descending to the outer aspect of the thigh and knee-joint.

Internal Circumflex.

The internal circumflex arises from the profunda near its commencement and is much smaller than the external circumflex. It passes inward around the upper extremity of the femur and anastomoses with the external.

The Three Perforating Arteries.

As the profunda femoris is descending it gives off in succession three branches, each called perforating, superior, middle and inferior. They derive their names from the fact that they perforate the adductor magnus muscle (the superior perforating the adductor brevis also) to reach the back of the thigh and supply the posterior femoral muscles.

Anastomotica Magna.

The anastomotica magna, the last branch of the femoral artery, arises from it just as that artery is about to pierce the adductor magnus and descends toward the knee after dividing into a superficial and a deep branch.

Besides the six foregoing branches the femoral artery gives off muscular branches to the muscles in its course.

The Popliteal Artery.

The popliteal artery is the continuation of the femoral. It begins where that artery terminates by piercing the insertion of the adductor magnus at the junction of the middle and lower thirds of the thigh, to appear on the back of the thigh, and passes downward and outward (the outward inclination being greatest at first) through the popliteal

space, to terminate at the lower border of the popliteus muscle, where it is passing beneath the tendinous arch of the soleus, by dividing into the anterior and posterior tibial arteries.

The artery rests successively on the posterior aspect of the femur, the posterior ligament of the knee-joint and the popliteal fascia which separates it from the popliteus muscle. It is surrounded by the mass of fat which fills the popliteal space. On its outer side it has above the tendon of the biceps and below the outer head of the gastrocnemius. On the inner side are the internal hamstring muscles and the inner head of the gastrocnemius.

Relations to Cords.

The artery is accompanied by the popliteal vein and the internal popliteal nerve. The artery is the deepest of the three cords; next it and hugging it closely is the vein, which is external to the artery as well as superficial; while the nerve is the most superficial and is somewhat external to the vein separated from it by some fat. When the artery reaches the commencement of the lower third of its course these relations change, for here the vein and nerve cross superficially to its inner side, where they remain to the termination of the artery.

At the commencement both the artery and vein lie some distance to the inner side of the internal popliteal nerve, because the nerve enters the space at its superior apex while the artery and vein enter some little distance down on the inner side; but since the vein and artery have an outward inclination and the nerve slightly the opposite they soon come into close relation. The internal popliteal nerve is one of the terminal branches of the great sciatic which descends the middle of the back of the thigh and divides at the popliteal space sending its other branch, the external popliteal, downward along the outer side of the space.

Branches.

SUPERIOR EXTERNAL ARTICULAR.	INFERIOR EXTERNAL ARTICULAR.
SUPERIOR INTERNAL ARTICULAR.	INFERIOR INTERNAL ARTICULAR.
AZYGOS ARTICULAR.	MUSCULAR.

The superior articular arteries surround the lower extremity of the femur just above the knee, the external passing beneath the tendon of the biceps and the internal beneath the adductor magnus.

The inferior articular arteries surround the upper extremity of the tibia just below the knee.

The azygos articular is a single branch which perforates the posterior ligament to enter the knee-joint.

The muscular branches are divided into two sets, superior muscular, distributed to the hamstring muscles, and inferior muscular, or sural, distributed to the gastrocnemius.

The Posterior Tibial Artery.

The posterior tibial artery, one of the two terminal branches of the popliteal, begins where that artery terminates at the lower border of the popliteus muscle, beneath the tendinous arch of the soleus and descends the back of the leg with a steady inclination inward to the inner aspect of the os calcis where it divides, between the internal malleolus and tendo Achilles into the internal and external plantar arteries.

Relations.

The posterior tibial artery for about the upper two-thirds of its course lies deep, covered by the triceps suræ, but for the rest of its course it is superficial, having emerged to the inner side of the tendo Achilles, because of its own inward inclination and because of the narrowing of the triceps suræ to a tendon.

The artery is accompanied by satellite veins and by the posterior tibial nerve. The nerve for the first few inches of the artery (to the lower part of the upper third of the leg) lies to the inner side of the artery and then crosses it posteriorly to assume a continuous external relation. The nerve crosses about where the peroneal branch arises.

Branches.

PERONEAL. TERMINAL. INTERNAL CALCANEAN.

Besides muscular branches to the muscles in its course, and its two terminal branches, the posterior tibial produces two branches, peroneal and internal calcanean. One of its earliest muscular branches gives off a recurrent branch which passes upward to the knee-joint.

I. Peroneal Artery.

The peroneal artery is nearly as large as the continuation of the posterior tibial, and arises from that artery high up, near its origin, the distance being about two inches. It first passes obliquely downward and

outward to the origin of the flexor longus pollicis muscle and then descends vertically beneath that muscle to terminate on the outer side of the os calcis.

Relations.

The peroneal in the upper, oblique, part of its course is covered, like its parent, by the triceps suræ muscle, but after reaching the flexor longus pollicis it is covered by that muscle in addition. In the lower part of the leg the difference between the two arteries in depth is very considerable, since the posterior tibial is here superficial while the peroneal is still covered by the flexor longus pollicis and the tendo Achilles.

Branches.

Just above the posterior tuberosity of the os calcis the peroneal and posterior tibial arteries are connected by a small transverse communicating branch. The peroneal gives muscular branches to the muscles in its course. About the lower third of the leg the peroneal gives off a large branch called the anterior peroneal which pierces the interosseous membrane to reach the front of the leg. The termination of the peroneal is distributed on the outer side of the heel by branches called external calcanean.

II. Internal Calcanean Branches.

The internal calcanean branches of the posterior tibial are three or four in number and are distributed to the inner side of the heel.

The Internal Plantar Artery.

The internal plantar, much the smaller of the two terminal branches of the posterior tibial, begins where that artery bifurcates midway between the posterior tuberosity of the os calcis, and the internal malleolus and passes forward along the inner side of the sole to terminate on the inner side of the great toe having given off muscular branches in its course.

The External Plantar Artery.

The external plantar, the larger and more important of the two terminal branches of the posterior tibial, begins where that artery bifurcates midway between the posterior tuberosity of the os calcis and the internal malleolus, and passes forward and outward between the first and second layers of muscles in the sole to the base of the fifth metatarsal bone where

it turns inward beneath the third layer of the muscles to cross to the inner side of the sole and terminate there at the posterior extremity of the first interosseous space by anastomizing with a communicating branch from the dorsalis pedis artery. That portion of the artery which crosses the sole from the outer to the inner side is called the plantar arch.

Branches.

Besides muscular branches, the external plantar gives off the following: digital and posterior perforating.

I. Digital.

The digital branches are four in number. They run forward to the cleft between the toes and there divide to supply plantar collateral branches to the sides of the toes, except the great toe and the inner side of the second toe. The outermost of the four is appropriated by the outer side of the little toe. Just before the digital arteries divide at the clefts of the toes, they each send up between the metatarsal bones a branch called perforating (anterior), to open into the digital branches on the dorsum of the foot.

II. Posterior Perforating.

The posterior perforating, three in number, pass up between the heads of the three outer interosseous muscles to anastomose with the metatarsea artery on the dorsum of the foot.

The Anterior Tibial Artery.

The anterior tibial artery begins where the popliteal forks, at the lower border of the popliteus muscle, beneath the tendinous arch of the soleus, and passes directly forward between the tibia and fibula to the front of the leg which it descends, lying, for the upper two thirds of its course, on the interosseous membrane, and for the lower third on the front of the tibia, to terminate on the middle of the front of the ankle joint, beneath the annular ligament, by assuming the name of dorsalis pedis.

Relations.

The anterior tibial is divided into three portions, upper, middle and lower thirds.

In its upper third it lies on the front of the interosseous membrane

between the tibialis anticus internally and the extensor longus digitorum externally. In its middle third it still lies on the interosseous membrane, but has reached the origin of the extensor proprius pollicis and this muscle lies on the outer side, while the tibialis anticus still remains internal.

In its lower third it lies on the front of the tibia and is crossed obliquely by the tendon of the extensor proprius pollicis, which displaces the tibialis anticus and becomes the internal relation, while the extensor longus digitorum again comes into relation with it externally.

The artery is accompanied by satellite veins and the anterior tibial nerve. The nerve is at first to its outer side; then for a short distance in front of it and then again to the outer side.

Branches.

The branches of the anterior tibial artery are muscular, a recurrent branch, which ascends to the front of the knee through the tibialis anticus muscle, and two malleolar branches, external and internal, which surround the tibia just above the ankle-joint and supply that joint.

The Dorsalis Pedis Artery.

The dorsalis pedis artery is the continuation of the anterior tibial. It begins beneath the annular ligament, about the middle of the front of the ankle-joint, and passes forward along the inner side of the dorsum of the foot to terminate at the posterior extremity of the first interosseous space by dividing into the dorsalis hallucis and the communicating.

Relations.

It has the same relations to muscles and cords as the lower third of the anterior tibial. To its inner side is the extensor proprius pollicis tendon, to its outer side the extensor longus digitorum and near its termination it is crossed by the tendon of the extensor brevis digitorum to the great toe. It lies between satellite veins and has the anterior tibial nerve to its outer side.

Branches.

TARSEA.	DORSALIS HALLUCIS.
METATARSEA.	COMMUNICATING.

I. Tarsea.

The tarsea branch passes outward on the tarsus.

II. Metatarsea.

The metatarsea branch passes outward on the bases of the metatarsal bones and receives the posterior perforating branches from the plantar arch. The metatarsea sends forward three branches called interosseous, which, after receiving the anterior perforating branches of the plantar digital arteries, divide at the clefts of the toes to form collateral digital branches for the dorsal aspect of the fifth, fourth and third toes and the outer side of the second toe.

III. Dorsalis Hallucis.

The dorsalis hallucis is one of the two terminal branches of the dorsalis pedis and runs forward to supply dorsal collateral digital branches for the great toe and inner side of the second toe.

IV. Communicating.

The communicating passes through the first interosseous space to anastomose with the termination of the external plantar, giving off a branch, the magna pollicis, which passes forward and divides to form plantar collateral digital branches for the great toe and inner side of the second toe.

The Internal Carotid Artery.

The internal carotid artery is one of the two terminal branches of the common carotid and begins where that artery terminates on a level with the upper border of the thyroid cartilage and ascends on the front of the transverse processes of the three upper cervical vertebræ to the carotid aperture situated about the centre of the basilar face of the petrous portion of the temporal bone; it then runs forward and inward along the carotid canal in this bone and emerges at its apex to pass forward in the cavernous groove beside the sella turcica, and, lastly, turns upward beside the anterior clinoid process and divides into its four terminal branches, viz: anterior cerebral, middle cerebral, posterior communicating and anterior choroid.

Relations.

Its relations to muscles and structures other than cords are as follows:

Behind it are the anterior tubercles of the transverse processes of the three upper cervical vertebræ, separated from the artery by the origin of

the rectus capitis anticus major. In front of it, and separating it from the second and third portions of the external carotid artery are the parotid gland, the stylo-glossus and stylo-pharyngeus muscles and the stylohyoid ligament. To its inner side are the pharynx and tonsil gland.

Its relations to cords are as follows:

At its commencement it lies external to the external carotid artery, but by the time the external carotid has reached the stylo-hyoid and posterior belly of the digastric muscles the internal has passed behind it and is thence forward separated from it by the structures mentioned above and by the glosso-pharyngeal nerve. Behind the internal carotid, where it is entering the carotid foramen, are situated the jugular and anterior condyloid foramina and from these emerge the internal jugular vein, the pneumogastric and glosso-pharyngeal nerves, consequently these cords are here behind the artery, but they speedily get to its outer side as they descend. The internal jugular vein and pneumogastric nerve continue external to the artery throughout, but the glosso-pharyngeal and hypoglossal nerves cross over the front of the artery: the hypoglossal near its commencement, the glosso-pharyngeal higher up.

The internal carotid artery is divided into four portions. The first portion, which is also known as the cervical portion, extends from its origin to the carotid aperture. Its relations were given above. The second, or petrous, portion is that part of the artery which lies in the carotid canal of the petrous portion of the temporal bone; the third, or cavernous, portion extends from the apex of the petrous bone along the sella turcica in the cavernous sinus to the anterior clinoid process, the fourth, or cerebral, portion ascends beside the anterior clinoid process.

Branches.

The first portion gives off no branches. The second portion produces one unimportant branch, the tympanic, which passes to the tympanum. The third portion gives origin to three branches. Two of these, the arteria receptaculi, are unimportant and are distributed to the cavernous sinus and dura mater; the third is an important branch, the opthalmic artery.

The Opthalmic Artery.

The opthalmic artery springs from the internal carotid about the termination of its third portion and passes forward into the orbit through the optic foramen, first lying below and external to the optic nerve, then crossing to the inner side of the nerve and running forward along the

inner wall of the orbit to divide at the internal angle of the orbit into two branches, frontal and nasal.

Branches.

The branches of the opthalmic artery are ten in number.

1. Lachrymal.

The lachrymal artery runs forward along the outer wall of the orbit and after supplying the lachrymal gland passes on to the upper eye-lid. It gives off temporo-malar branches which pass through the bone to the temporal muscle.

2. Supra-Orbital.

The supra orbital runs forward on the levator palpebræ muscle and escaping to the forehead through the supra-orbital foramen, is there distributed by a superficial and a deep branch.

3 and 4. Anterior and Posterior Ethmoidal.

The anterior and posterior ethmoidal arteries escape through the anterior and posterior ethmoidal foramina, and are distributed to the dura mater, ethmoidal cells and nasal fossæ.

5. Palpebral.

The palpebral arteries, superior and inferior, arise from the opthalmic near its termination. The superior runs outward on the upper lid near its free edge, between the orbicularis palpebrarum and the tarsal cartilage and is there distributed; the inferior does the same for the lower lid. The two sometimes arise by a common trunk.

6. Frontal.

The frontal, one of the two terminal branches of the opthalmic artery, emerges at the inner angle of the orbit and ascends to be distributed along the middle of the forehead.

7. Nasal.

The nasal, the other terminal branch of the opthalmic artery, emerges at the inner angle of the orbit and is distributed along the bridge of the nose.

8. Arteria Centralis Retinæ.

The arteria centralis retinæ pierces the optic nerve and runs forward in it to reach the retina and be there distributed.

9. Muscular.

The opthalmic gives off numerous muscular branches in its course which are divided into two sets, superior and inferior, the superior springing by one trunk and the inferior by another.

10. Ciliary.

The ciliary arteries consist of three sets, viz:

1st. Short ciliary branches, which are numerous small arteries which pierce the sclerotic around the optic nerve and supply the choroid.

2d. Long ciliary, which are two branches piercing the sclerotic on opposite sides and running forward between it and the choroid to be distributed to the iris.

3d. Anterior ciliary branches, which are the offspring of muscular branches and pierce the sclerotic near the front of the eye to reach the iris.

The branches from the fourth or cerebral portion are four.

Anterior Cerebral Artery.

The anterior cerebral artery, one of the terminal branches of the internal carotid, runs forward in the longitudinal fissure, ascends the genu of the corpus callosum and runs backward along that body.

Passing from the anterior cerebral of one side to that of the other, soon after their origin, is a communicating branch called the anterior communicating artery.

Middle Cerebral Artery.

The middle cerebral, arising as one of the terminal branches of the internal carotid, passes outward along the fissure of Sylvius to be distributed to the anterior and middle lobes of the cerebrum and to the convolutions forming the island of Reil.

Anterior Choroid Artery.

The anterior choroid pierces the base of the brain to enter the descending cornu of the lateral ventricle and form the choroid plexus.

Posterior Communicating Artery.

The posterior communicating artery, the last of the four terminal branches of the internal carotid, passes backward to anastomose with the posterior cerebral of the basilar artery.

Circumscribing the six-sided space at the base of the brain is a series of arteries and their communications forming what is called the vascular circle of Willis. Beginning in front we have the anterior communicating, and, following the arteries back on one side, they come in this order, anterior cerebral, internal carotid, posterior communicating, posterior cerebral and the termination of the basilar artery. Following them forward from the basilar artery they come in the reverse order.

THE VEINS.

The veins are the vessels which return the blood which the arteries have carried to the capillaries; consequently the course of the venous current is the opposite of the arterial, viz: towards the heart, into which they open after converging to form two trunks, superior and inferior venæ cavæ. The veins, as a rule, accompany the arteries either singly or in pairs, as satellite veins, and the size of the vein, or veins, which return the blood from a part is much greater than that of the arteries which carry the blood to the part. In the extremities there are two sets of veins, a superficial set which course just beneath the skin in the superficial fascia, and a deep set, the satellite veins; so that here the veins accompanying the arteries are remarkably small, especially in the upper extremity where the superficial are large and numerous. Ultimately, however, after a longer or shorter course, the two sets coalesce. The companion vein of an artery, as a rule, receives accessaries corresponding to the branches which are emitted by the artery, though to this there are some notable exceptions.

The Veins of the Lower Extremity.

The veins of the lower extremity consist of two sets, superficial and deep or satellite.

Beginning, then, with the satellite veins, we find that those of the posterior tibial artery have been formed, where that artery terminates, by the coalescence of the four satellite veins of the two plantar arteries, and ascend receiving tributaries in correspondence with the branches of the artery until they reach the point where the popliteal artery terminates, and there unite with the satellite veins of the anterior tibial artery to form the popliteal vein. The satellite veins of the anterior tibial artery are the continuation of those of the dorsalis pedis, and, ascending and growing by accessaries corresponding to the branches of the artery, they terminate by coalescing with the satellite veins of the posterior tibial to form the popliteal vein. The popliteal vein thus formed lies at first to the inner side of the artery, but as it ascends it crosses superficially to the outer side and there remains until it terminates at the lower third of the thigh by becoming the femoral. The popliteal vein receives not only

tributaries corresponding to the branches of the popliteal artery, but also one of the superficial veins called the short saphenous. The femoral vein, commencing where the popliteal ceases at the lower third of the thigh, ascends in company with its artery, lying at first to its outer side, then behind and finally internal to it and terminates by becoming the external iliac vein at the point where the femoral artery commences. The femoral vein, as it advances, receives accessaries corresponding to the branches of its artery and also the second of the two superficial veins, the long saphenous, which opens into it just below Poupart's ligament. Thus it is seen that from the commencement of the femoral to the termination of the popliteal artery, the artery of the lower extremity is accompanied by only one vein.

The Superficial Veins of the Lower Extremity.

The superficial veins of the lower extremity consist of two trunks called external or short and internal or long saphenous.

Short Saphenous Vein.

The short saphenous vein begins on the outer side of the dorsum of the foot, ascends behind the external malleolus and, with an inclination inward, gains the groove between the two heads of the gastrocnemius muscle and continues its course upward to open into the popliteal vein, having received numerous accessions in its course.

Long Saphenous Vein.

The long saphenous commences on the inner side of the dorsum of the foot and ascends in front of the internal malleolus, behind the internal condyle of the femur; and then, after ascending the inner side of the thigh for some distance, inclines to the front and, just below Poupart's ligament, pierces the fascia lata and opens into the femoral vein, gathering as it runs tribute from many smaller superficial veins and receiving, just as it is about to terminate, the veins from the first four branches of the artery.

External Iliac Vein.

The external iliac vein begins where the femoral terminates and passes upward and inward along the brim of the pelvis to unite with the internal iliac vein on the disk between the fifth lumbar vertebra and the base of the sacrum to form the common iliac vein. It receives accessaries cor-

responding to the two branches of the external iliac, epigastric and circumflex iliac arteries.

The two external iliac veins bear different relations to their arteries. The vein of the left side is internal and abreast of its artery, then internal and on a plane posterior; while that of the right is first internal, then behind, then behind and external.

Internal Iliac Vein.

The internal iliac vein is formed by the coalescence of the veins accompanying the branches of the internal iliac artery. The veins of the visceral branches are so numerous and intersecting that they form plexuses. The vein thus formed ascends behind its artery and unites with the external iliac vein on the disk between the fifth lumbar vertebra and the sacrum to produce the common iliac vein.

The Common Iliac Vein.

The common iliac vein results from the union of the external and internal iliac veins on the disk between the fifth lumbar vertebra and the sacrum, and passes upward and inward to unite with its fellow of the opposite side on the right side of the disk between the fourth and fifth lumbar vertebræ to form the inferior vena cava. The average length of the vein is two inches, but the vein of the left side is the longer. The relation of each vein to its artery is as follows:

The left vein is behind and internal to its own artery and crosses behind the right artery. The right vein is behind and external to its artery.

The Inferior Vena Cava.

The inferior vena cava begins by the union of the two common iliac veins on the right side of the disk between the fifth and fourth lumbar vertebræ and ascending to the right of the abdominal aorta perforates the diaphragm and empties into the venous auricle.

The inferior vena cava receives tributaries corresponding only to some of the branches of the aorta. Eventually it receives all of this blood; but the veins accompanying the arteries distributed to the organs of digestion coalesce into a trunk, the portal vein, which discharges itself into the capillaries of the liver, from which the blood is collected by the hepatic veins and by them discharged into the inferior vena cava at the posterior border of the liver.

The Portal Vein.

The portal vein is formed by the union of the superior mesenteric and splenic veins behind the head of the pancreas and ascends in the right border of the lesser omentum, between and behind the hepatic artery and duct, to the transverse fissure of the liver where it divides into a branch for each of the two lobes. It is about four inches long. Although the portal vein is formed directly by the union of the superior mesenteric and splenic veins, it also conveys the blood from the inferior mesenteric and gastric veins, for these two open into the splenic veins. As stated, the blood carried to the liver by the portal vein is collected by the hepatic veins, which emerge at three or four apertures on the posterior border of the liver and open into the inferior vena cava.

The Spermatic Vein.

The spermatic vein begins in the testicle by a plexus which ascends as numerous small veins along the cord to the internal abdominal ring, where, uniting into two veins, they pass upward and inward and soon unite to form a single trunk. The vein of the right side opens into the inferior vena cava, while that of the left empties into the left renal vein, having been crossed by the sigmoid flexure of the colon.

The Veins of the Upper Extremity.

The veins of the upper extremity are arranged in two sets, deep and superficial.

The Deep Veins.

The deep or satellite veins of the upper extremity are remarkably small, owing to the great amount of blood flowing through the superficial veins.

The satellite veins of the radial and ulnar arteries, formed by the veins accompanying the branches of those two arteries, coalesce, a finger's breadth below the middle of the front of the elbow-joint, to form the satellite veins of the brachial artery. The brachial satellite veins, having collected the blood from the veins accompanying the branches of the brachial artery, unite, where the axillary artery terminates, to form the axillary vein, which passes upward and inward, lying to the inner front aspect of the axillary artery to cease at the outer border of the first rib by becoming the subclavian vein, having received acccessions in correspondence with the branches of the axillary artery.

The Superficial Veins.

The superficial veins of the upper extremity are seven in number.

Anterior Ulnar.

The anterior ulnar vein begins on the inner side of the front of the forearm and ascends to unite with the posterior ulnar vein just below the elbow.

Posterior Ulnar.

The posterior ulnar vein passes up the inner side of the back of the forearm, turns forward and unites with the anterior ulnar, just below the elbow, to form the common ulnar.

The Common Ulnar.

The common ulnar vein ascends to the inner side of the front of the elbow to unite with the median basilic vein to form the basilic vein.

Radial.

The radial vein commences on the outer side of the back of the hand and ascends with an inclination forward and inward to terminate at the outer side of the front of the elbow by uniting with the median cephalic to form the cephalic veins.

Median.

The median vein ascends along the middle of the front of the forearm from the hand to a little below the front of the elbow where it divides into two veins, the median cephalic and median basilic. The median cephalic passes upward and outward to unite with the radial and form the cephalic vein. The median basilic passes upward and inward to join the common ulnar and form the basilic vein.

Basilic.

The basilic vein commences at the inner side of the front of the elbow by the union of the common ulnar and the median basilic veins, and ascends the inner side of the arm, lying to the inner side of the brachial artery. It is first superficial to the artery, lying superficial to the investing fascia, but pierces that fascia to reach the level of the artery, and

terminates by uniting with the brachial satellite veins, where they coalesce to produce the axillary vein.

Cephalic.

The cephalic vein begins at the outer side of the front of the elbow, being formed by the union of the median cephalic and radial veins, and ascends the arm skirting the outer edge of the biceps muscle, then lying in the interval between the deltoid and pectoralis major and terminates in the axillary near the termination of that vein. Near its termination the cephalic receives a communication from one of the veins of the neck, the external jugular.

The Axillary Vein.

The axillary vein is formed by the junction of the brachial satellite veins and the basilic, at the termination of the axillary artery. It passes upward, a continuous relation to the inner front aspect of the axillary artery, to terminate where that artery commences by becoming the subclavian vein. It increases in size as it ascends by receiving tributaries corresponding to the branches of the axillary artery; and, near its termination, it receives the cephalic vein.

The Subclavian Vein.

The subclavian vein is the continuation of the axillary.

It passes horizontally inward behind the clavicle to unite, behind the sterno-clavicular articulation, with the internal jugular vein and form the vena innominata. The subclavian vein is in relation with its artery at its termination, there lying to its inner side, and at the commencement of the artery where the vein is found lying below. Between these two points the vein is below the artery and separated from it by the scalenus anticus muscle.

The Right Vena Innominata.

The right vena innominata begins behind the right sterno clavicular articulation by the union of the right subclavian and internal jugular veins and descends nearly perpendicularly to unite with the left vena innominata to form the superior vena cava. It is about one and one-fourth inches long and lies external to the arteria innominata.

The Left Vena Innominata.

The left vena innominata, or great transverse vein, is formed behind the left sterno-clavicular articulation by the union of the left subclavian and internal jugular veins. It passes almost horizontally to the right, lying upon the arch of the aorta and in front of the origin of the three arteries springing therefrom, and unites with the right vena innominata to form the superior vena cava. The vena innominata receives accessions corresponding to the branches of the subclavian artery, except the veins accompanying the supra-scapular and transversa colli arteries which open into a superficial vein of the neck, the external jugular, which in turn opens into the subclavian.

Superior Vena Cava.

The superior vena cava is formed at the lower border of the second costal cartilage of the right side by the confluence of the two venæ innominatæ and descends to the right of the ascending aorta for about three inches to open into the venous auricle of the heart.

The Azygos Veins.

The azygos veins, right and left, are a means of communication between the two venæ cavæ.

Right Vena Azygos.

The right vena azygos begins in the right lumbar region by a communication with one of the lumbar veins, or the renal vein, or even the inferior vena cava itself, and ascends along the front of the vertebral column, through the aortic opening in the diaphragm, to the right of the descending aorta, until it reaches the third dorsal vertebra, where it arches forward over the right bronchus and opens into the superior vena cava. It receives the right intercostal veins as far up as it extends and also the left vena azygos.

The Left Vena Azygos.

The left vena azygos begins in the left lumbar region in the same way as the right does and ascends to pierce the left crus of the diaphragm and pass upward beside the vertebral column as high as the sixth dorsal vertebra, where it crosses behind the aorta and opens into the right vena

azygos. It receives the left intercostal veins as high up as it extends. The intercostal veins of each side, which lie above the azygos veins, open into a vein called the superior intercostal, right or left, the right superior intercostal opening into the right subclavian, the left into the left vena innominata.

Veins of the Head and Neck.

The veins of the head and neck comprise three veins called jugular, external, internal and anterior, and their formative branches.

The Internal Jugular Vein.

The internal jugular vein begins at the foramen lacerum posterius by the convergence of the vessels from the interior of the cranium and descends the neck, lying first behind the internal carotid and then external to the common carotid artery to terminate behind the sterno-clavicular articulation by uniting with the subclavian vein to form the vena innominata of its side. It receives nearly all the blood returned from the ramification of the external carotid artery, the veins conveying this blood being thus described: The temporal and internal maxillary veins, having collected the blood from the distribution of their arteries, coalesce in the substance of the parotid gland to form a common trunk called the temporo-maxillary, which, after descending a short distance, divides into two branches, one mounting over the sterno-mastoid muscle to become the external jugular, while the other opens into the facial vein. The facial vein begins on the forehead under the name of the frontal vein; this descends near the centre of the forehead to the internal angle of the eye, where it is called the internal angular vein, and then passes downward with the artery, taking the name of facial vein. Soon after reaching the neck it is joined by a branch of the temporo-maxillary vein and then it opens into the internal jugular vein about on a level with the upper border of the thyroid cartilage. It sometimes receives the lingual and superior thyroid veins, though usually these open into the internal jugular vein.

The External Jugular Vein.

The external jugular vein commences in the parotid gland as a branch of the temporo-maxillary vein, which is joined by the posterior auricular vein and sometimes by the occipital, and descends across the outer face of the sterno-cleido-mastoid muscle, thence along its posterior border, across the third portion of the subclavian artery to open into the subcla-

vian vein. Just before terminating it receives the supra-scapular and transversa colli veins and has a communication across the clavicle with the cephalic vein.

The Anterior Jugular Vein.

The anterior jugular vein descends the front of the neck beside the middle line and just above the sternum, turns outward beneath the sterno-cleido-mastoid muscle and opens into the subclavian vein. It is always small and sometimes inconspicuous.

The Sinuses of the Dura Mater.

The veins which return the blood from the brain consist of those upon the surface of the brain, called superficial cerebral, those of the interior of the brain and certain canals in the layers of the dura mater, which receive the blood from the foregoing, called sinuses.

The Superficial Cerebral Vein.

The superficial cerebral veins, although they may be seen on the whole surface of the brain, are especially long and numerous on the upper aspect. These veins open into the sinuses which are near them.

Deep Cerebral Veins.

The blood from the interior of the brain is collected by veins which ultimately coalesce into two (the venæ Galeni) which emerge beneath the posterior lobes of the cerebrum, one on each side, and open into the straight sinus of the tentorium.

The Sinuses of the Dura Mater.

The sinuses of the dura mater are nine in number as follows:

Superior Longitudinal Sinus.

The superior longitudinal sinus is found running from before backward in the attached margin of the falx major. Beginning in front at the foramen coecum it passes backward, grooving the vault of the cranium, to terminate at the anterior occipital protuberance by dividing into the two lateral sinuses. It receives the superior superficial veins, which open into it from behind forward.

The Lateral Sinuses.

The lateral sinuses begin at the anterior occipital protuberance and pass outward along the horizontal limbs of the occipital cross, then curve downward over the posterior inferior angle of the parietal bone, the mastoid portion of the temporal bone and again on the occipital bone to terminate in the jugular vein of either side at the posterior lacerated foramen. The position of these sinuses is indicated in the dried bone by a groove.

The Occipital Sinuses.

The occipital are a pair of small sinuses which commence around the foramen magnum and ascend in the attached margin of the falx minor to open, at the anterior occipital protuberance, into the commencement of the lateral sinuses.

Inferior Longitudinal Sinus.

The inferior longitudinal sinus is small and unimportant. It runs backward in the lower, free, concave margin of the falx major to terminate, when it reaches the tentorium in the straight sinus.

The Straight Sinus.

The straight sinus, triangular in shape, runs horizontally backward along the centre of the upper surface of the tentorium, between the layers of the falx major, to terminate at the anterior occipital protuberance.

It is thus seen that four sinuses, superior longitudinal, straight and two occipital convey their blood to the anterior occipital protuberance, and that the blood is removed from this point by the lateral sinuses, hence the place is called the torcular Herophili. The sinuses above described are found at the upper and back part of the brain, but there are others situated at the base as follows:

The Cavernous Sinus.

The cavernous sinus occupies the groove on either side of the sella turcica. It commences in front by receiving the opthalmic vein and passes backward to terminate at the apex of the petrous bone by dividing into two, superior and inferior petrosal. Passing through the cavernous sinus from behind forward are the internal carotid artery and several

nerves. The sinuses of the two sides are connected by transverse communications, one in front and one passing behind across the sella turcica thus forming an arrangement called the circular sinus or sinus of Winslow.

The Superior Petrosal Sinus.

The superior petrosal sinus passes outward and backward along the upper border of the petrous bone to open into the lateral sinus just where it curves downward.

The Inferior Petrosal Sinus.

The inferior petrosal sinus passes backward and outward along the posterior border of the petrous bone to terminate with the lateral sinus at the foramen lacerum posterius to form the internal jugular vein.

The Transverse Sinus.

The transverse sinus consists of one or more channels of communication, across the basilar process of the occipital bone, between the two inferior petrosal sinuses.

The Veins of the Diploe.

Ramifying between the tables of the bones of the skull are numerous veins called diploetic. They take the name of the region they occupy and finally converge to four trunks which open either into the sinuses of the interior or the veins of the exterior. Connecting the sinuses of the interior with the veins of the exterior of the head are several veins which pass through foramina such as the mastoid and parietal.

The Spinal Veins.

The spinal veins consist of three sets, as follows:

Dorsal Spinal Veins.

The dorsal spinal veins are numerous veins forming a net-work on the exterior of the vertebræ.

Meningo-Rachidian Veins.

The meningo-rachidian are four veins perpendicular in direction, which

lie within the spinal canal between the bone and dura mater, two in front and two behind.

Medulli-Spinal Veins.

The medulli-spinal are numerous veins ramifying beneath the arachnoid membrane of the spinal cord.

The Cardiac Veins.

The veins of the heart are two, as follows:

The Great Cardiac Vein.

The great cardiac vein ascends in the anterior ventricular groove, winds around the left auriculo-ventricular groove and opens into the right auricle. The last inch of its course is known as the coronary sinus.

The Posterior Cardiac Vein.

The posterior cardiac vein is small and ascends in the posterior ventricular groove to open into the great cardiac vein.

THE LYMPHATIC SYSTEM.

The lymphatic system consists of numerous small vessels ramifying in nearly every tissue of the body, and of small, reddish, pea-like bodies called lymphatic glands, found at intervals along the lymphatic vessels. The lymphatic vessels are intended for the most part to remove from the tissues the detritus of assimilation, consisting mainly of unexpended plasma; consequently the course of their circulation is from the circumference towards the centre, and in their route they will be found to accompany the veins.

Wherever they are found the lymphatics consist of two sets, superficial and deep. In the extremities the superficial set is found just beneath the skin; the deep in and among the muscles. In the viscera the superficial set ramifies on the surface, while the deep is found in the structure. The greater portion of the lymphatics of the body converge to form one large vessel, the thoracic duct, which empties into the venous current near the heart.

The Thoracic Duct.

The thoracic duct begins on the front of the body of the second lumbar vertebra by a considerable dilatation called receptaculum chyli, which, narrowing to a tube the size of a goose quill, ascends the front of the vertebral column behind the descending aorta, passes through the aortic opening of the diaphragm and continues upward as high as the fourth dorsal vertebra, where it inclines to the left and continues thence an oblique ascent behind the arch of the aorta to a point on a level with the seventh cervical vertebra, where it arches forward and downward and opens into the commencement of the left vena innominata. Opening into the commencement of the right vena innominata is another and much smaller lymphatic duct (ductus lymphaticus dexter) which conveys lymph furnished it by the right upper extremity and right side of the head and neck.

Lymphatics of the Lower Extremity.

The superficial lymphatics of the lower extremity are found crowding upward in immense numbers along the course of the saphenous veins and, reaching the saphenous opening in the fascia lata, where the vein terminates near Poupart's ligament, they then pass through a set of lymphatic glands. The deep lymphatic vessels accompany the deep veins upward to the groin, where they are connected with a set of glands, lying beneath the fascia lata and superficial muscles, called the deep lymphatic glands of the groin. Along the course of these vessels are found a few glands, some in the popliteal space and one on the front of the interosseous membrane of the leg. The lymphatic vessels from the external organs of generation and from the abdominal parietes can be traced to a third set of glands, which form a chain along Poupart's ligament, lying superficial and above the glands around the saphenous opening.

All these vessels pass beneath Poupart's ligament to become the external iliac lymphatics which accompany the external iliac vessels and unite with the internal iliac lymphatics to form the common iliac lymphatics, which accompany the common iliac vessels and unite with those of the opposite side to form the lumbar lymphatics. Scattered at intervals along these vessels from Poupart's ligament are lymphatic glands. The lumbar lymphatics ascend along the aorta, constantly increasing in size by accessions from the abdominal viscera, and having passed through numerous glands, and lessened in number as they increased in size, they eventually open into the receptaculum chyli, which is so named from the fact that the lymphatics which it receives from the small intestine are, during the process of digestion, filled with chyle.

The Lymphatics of the Upper Extremity.

The lymphatics of the upper extremity, like those of the lower, consist of a superficial and a deep set. The superficial ascend in company with the superficial veins and the deep accompany the deep veins, both converging to the arm pit where there are some twelve or fifteen lymphatic glands. Besides the vessels from the upper extremity these glands also receive those from the chest wall and mammary gland. A few glands are found along the course of the lymphatics before they reach the axilla, some at the elbow and some along the brachial vessels; these, however, are small and unimportant. From the axillary glands the vessels proceed along the course of the subclavian vein, opening on the left side into the

termination of the thoracic duct and on the right into the ductus lymphaticus dexter.

Lymphatics of the Head and Neck.

The lymphatics of the head and neck consist of vessels which have come from the exterior of the head and others which have converged from veins supplying the internal and external jugular veins, no lymphatics, however, being found in the substance of the brain.

These vessels descend along the external, and especially the internal, jugular veins and on the right side open into the ductus lymphaticus dexter while on the left they join the thoracic duct.

The Lymphatics of the Thorax.

The lymphatics accompanying the intercostal vessels open into the thoracic duct. Those from the right lung, some portion of the thoracic parietes, diaphragm and even some portion of the upper surface of the liver and the short border of the heart seek the ductus lymphaticus dexter; while those from the left lung, left side of the thorax and most of the heart join the thoracic duct. The vessels from the lungs pass through a set of glands situated around the bifurcation of the trachea called the bronchial glands.

THE NERVOUS SYSTEM.

The Cranial Nerves.

The cranial nerves comprise twelve pairs, one on each side, those of one side having their counterpart on the other.

The definition of a cranial nerve is that it appears at the base of the brain and emerges through an aperture in the skull. The point on the base of the brain where the nerve appears is called its apparent origin, since it may be traced into the interior of the brain to what is called its real origin. The real origin of many of the nerves is still a matter of dispute.

The cranial nerves are named numerically in pairs from before backward; besides which each pair is known by another or several other names derived from the part to which the nerve is distributed. The following table gives the synonymes of the twelve pairs:

FIRST PAIR, OLFACTORY.
SECOND PAIR, OPTIC.
THIRD PAIR, MOTORES OCULORUM.
FOURTH PAIR, PATHETIC (TROCHLEARES).
FIFTH PAIR, TRIFACIAL (TRIGEMINUS).
SIXTH PAIR, ABDUCENTES.
SEVENTH PAIR, FACIAL, PORTIO DURA.
EIGHTH PAIR, AUDITORY, PORTIO MOLLIS.
NINTH PAIR, GLOSSO-PHARYNGEAL.
TENTH PAIR, PNEUMOGASTRIC, PAR VAGUM, VAGUS.
ELEVENTH PAIR, SPINAL ACCESSORY.
TWELFTH PAIR, HYPOGLOSSAL (LINGUAL).

These twelve pairs were formerly considered as only nine from the fact that, as will be seen, they emerge through nine foramina in the cranium. The classification into nine pairs is known as that of Willis and the one just given as that of Sömmering. The two classifications are similar for the first six pairs, the seventh pair in Willis' classification consisted of the

seventh and eighth, while the eighth consisted of the glosso-pharyngeal, pneumogastric and spinal accessory and the ninth of the hypoglossal.

A general outline of the cranial nerves successively, from their apparent origin to their point of emergence, will first be given and afterwards each pair will be taken up and described.

The first seen on the base of the brain from before backward is the first pair. The first nerves lie on the under surface of the anterior lobe of the cerebrum in a groove a little external to the longitudinal fissure, having its commencement by a three forked origin just in front of the anterior perforated space. Near the anterior extremity of the anterior cerebral lobe it enlarges into an oval-shaped mass which lies upon the cribriform plate of the ethmoid bone and sends its branches of distribution through the foramina seen there.

The second nerve is first seen under the name of the optic tract, approaching its fellow from the outer aspect of the crus cerebri and passing beside the tuber cinereum and uniting in front of it with its fellow to form the optic chiasm or commissure from which the two optic nerves diverge forward to enter the orbit through the optic foramina.

The third nerve is seen emerging to the inner side of the crus cerebri, just in front of the pons Varolii, and runs forward to leave the cranium through the anterior foramen lacerum.

The fourth nerve has its apparent origin external to the third, on the optic side of the crus cerebri, and also has its exit through the anterior foramen lacerum.

The fifth is the largest of the cranial nerves and is first seen just behind the origin of the fourth. It pierces the lateral aspect of the pons Varolii and splits into three portions, opthalmic, superior and inferior maxillary, which require three apertures of exit from the cranium.

The opthalmic leaves through the anterior foramen lacerum, the supepior maxillary through the foramen rotundum, the inferior maxillary through the foramen ovale.

The sixth nerve takes its apparent origin behind that of the fifth from the upper constricted portion of the medulla oblongata, just behind the pons Varolii, and passes forward to gain egress through the anterior foramen lacerum, which is thus seen to transmit three entire cranial nerves, viz: third, fourth and sixth, and a part of another, viz: the opthalmic branch of the fifth.

The seventh, eighth, ninth, tenth and eleventh all arise in the order named, from above downward, in the groove between the corpora olivare and restiformia of the medulla oblongata. The seventh and eighth leave

the cranium through the same opening, the internal auditory meatus, while the ninth, tenth and eleventh all gain exit through the posterior foramen lacerum.

The twelfth has its apparent origin to the inner side of the five preceding nerves, from the groove between the corpora olivare and pyramidale, by numerous filaments which are speedily collected into two cords, which unite to form the nerve as it emerges through the anterior condyloid foramen.

The First Nerve.

The first or olfactory nerve arises by a three forked origin close to the anterior perforated space. The external or long root consists of white fibres and may be traced along the fissure of Sylvius into the middle lobe of the cerebrum; the middle root is of gray matter and springs from the posterior part of the anterior lobe; the inner or short root is of white fibres and also arises from the posterior part of the anterior lobe. The three roots unite to form the nerve, just in front of the anterior perforated space, which passes forward, triangular in shape and grayish in color, lying in a groove on the under surface of the anterior lobe of the cerebrum a little external to the longitudinal fissure. The nerve swells into an oblong grayish enlargement, called the bulbus olfactorius, which lies beside the crista galli on the cribriform plate of the ethmoid bone. From the under surface of the olfactory bulb are given off some twenty filaments, which descend into the nose through the foramina of the cribriform plate to be distributed to the mucous membrane of the nose as far down as the middle turbinated bone. These filaments may be arranged in three sets, viz: those to the septum, those to the external wall and those to the roof of the nose.

Second Nerve.

The second or optic nerve has its apparent origin just external to the crus cerebri, whence it may be traced to its deep or real origin from various parts of the optic thalamus and from the corpora quadrigemina. Winding around the outer side of the crus cerebri, it passes forward and inward beside the tuber cinereum and in front of it unites with its fellow to form the optic commissure or chiasm. The portion extending from the origin to the optic chiasm is called the optic tract. From the optic chiasm the two optic nerves diverge anteriorly to enter the orbit through the optic foramina, each piercing the sclerotic and choroid coats of the eye-ball to expand into the retina.

The connection between the optic tract, chiasm and nerve is as follows: The optic tract is composed of filaments, the outermost of which pass into the nerve of that side, while the innermost curve over, through the chiasm, to form the innermost fibres of the opposite tract, and the middle fibres of the tract of one side pass through the chiasm to form the middle fibres of the nerve of the opposite side; and the innermost fibres of one nerve pass through the chiasm and become the innermost fibres of the opposite nerve, thus accounting for all the filaments.

Third Nerve.

The third nerve, or motor oculi, leaves the brain to the inner side of the crus cerebri close to the front of the pons Varolii, passes forward in the outer wall of the cavernous sinus, enters the orbit through the foramen lacerum anterius and divides into two branches, which supply all the muscles of the orbit except the superior oblique and external rectus. As it enters the orbit it lies between the two heads of the external rectus muscle and thence one of its branches ascends to supply the superior rectus and levator palpebræ, while the other is distributed to the internal and inferior recti and the inferior oblique. All its fibres enter the muscles on their ocular aspects.

Fourth Nerve.

The fourth nerve, or patheticus, appears external to the apparent origin of the third, viz: to the outer side of the crus cerebri, and passing forward in the outer wall of the cavernous sinus, enters the orbit through the foramen lacerum anterius and is distributed to the superior oblique from its orbital surface.

Fifth Nerve.

The fifth nerve, or trifacial, or trigeminal, appears just behind the fourth emerging from the lateral aspect of the pons Varolii. It arises by two roots which are known as the anterior, small or motor root and the posterior, large or sensitive root. The large root passes forward over the superior border of the petrous bone near its apex, and then swells into a ganglion known as that of Gasser, which lies in the digital depression seen on the anterior face of the petrous bone. The small root passes forward beneath the large and is found lying under the ganglion of Gasser without participating in its formation.

The ganglion divides into three branches, opthalmic, superior maxillary and inferior maxillary. The latter is joined bodily by the small root of the nerve and is, therefore, the only one of the three divisions possessing motor endowments.

I. The Opthalmic Nerve.

The opthalmic branch passes forward and soon divides into three branches, lachrymal, frontal and nasal, which enter the orbit through the foramen lacerum anterius.

1. Lachrymal Nerve.

The lachrymal nerve passes forward along the outer wall of the orbit to supply the lachrymal gland, and, not being exhausted in this duty, continues its course to emerge at the outer angle of the orbit and supply the adjacent integument.

2. Frontal Nerve.

The frontal branch passes forward on the levator palpebræ muscle and divides into two branches, supra-orbital and supra-trochlear.

1st. The supra-orbital branch emerges from the orbit at the supra-orbital foramen to supply the upper lid and muscles and integument of the forehead as far back as the vertex of the skull.

2d. The supra-trochlear branch advances to the inner angle of the orbit where it emerges above the fovea trochlearis, hence its name, and is distributed to the inner angle of the eye and the integument of the root of the nose and middle of the forehead.

3. Nasal Nerve.

The nasal branch crosses the optic nerve, advances along the inner wall of the orbit, re-enters the cranium through the anterior ethmoidal foramen and is there found lying in the slit beside the crista galli, whence it sinks into the cavity of the nose and divides into a branch for the mucous membrane of the nose, and another to descend along the posterior aspect of the nasal bone to its lower edge, where it emerges through the notch found there and supplies the integument of the nose to its tip. Just as the nasal nerve is entering the ethmoidal foramen it gives off a branch called the infra-trochlear, which passes forward to emerge at the inner angle of the orbit below the fovea trochlearis and supply the lach-

rymal sac and inner angle of the eye. Besides the infra-trochlear it gives off in the orbit three other branches; one to the opthalmic ganglion of the sympathetic system and two ciliary branches which pierce the sclerotic coat, pass forward between it and the choroid and are distributed to the iris.

II. Superior Maxillary Nerve.

The superior maxillary branch of the fifth nerve, like the opthalmic, has a forward course. It gains egress through the foramen rotundum, continues its forward direction across the spheno-maxillary fossa, along a groove on the floor of the orbit, sinks beneath the floor and emerges at the infra-orbital foramen on the face to give sensibility to adjacent parts, viz: the lower lid, cheek, side of the nose and upper lip.

Branches.

Besides the terminal ones, the branches of the superior maxillary are the following, emitted in the order given:

1. Orbital.

The orbital, or temporo-malar, branch enters the orbit through the spheno-maxillary fissure and divides into two branches, temporal and malar. The temporal branch enters the temporal fossa through the outer wall of the orbit, while the malar branch continues along the outer wall of the orbit to emerge on the cheek at the outer angle.

2. Spheno-Palatine.

The spheno-palatine are two branches of communication which descend to Meckel's ganglion of the sympathetic in the spheno-maxillary fossa.

3. Dental Branches.

The chief distribution of the superior maxillary is to the teeth and gums of the upper jaw and this is effected by two branches, anterior and posterior dental. The posterior dental is first emitted and supplies the molar and bicuspid teeth. The anterior dental leaves the main trunk just as it is about to emerge on the face and supplies the two incisors, the canine and the front bicuspid. The anterior and posterior dental nerves anastomose in the bone and supply each tooth with as many filaments as the tooth has fangs, besides giving twigs to the gums.

III. Inferior Maxillary Nerve.

The inferior maxillary branch of the fifth nerve consists of a branch from the ganglion of Gasser and the small motor root of the fifth nerve, which unite and pass downward through the foramen ovale, immediately after emerging from which the nerve divides into an anterior and a posterior trunk. The distribution of each trunk is as follows:

1. The anterior trunk breaks up into branches which supply the muscles of mastication, each branch bearing the name of the muscle to which it is distributed and conveying motor influence.

2. The posterior trunk divides into three branches, inferior dental, gustatory and auriculo-temporal.

1st. Inferior Dental.

The inferior dental branch curves forward and downward to enter the dental foramen of the lower jaw and run along a canal in the bone giving filaments to all the teeth of the lower jaw. As it passes the mental foramen it gives off a branch which escapes through that foramen and supplies the integument of the lower lip. Just before entering the dental foramen the nerve gives off a branch called the mylo-hyoidean, which descends along the groove on the inner surface of the inferior maxilla and is distributed to the mylo-hyoid muscle and the anterior belly of the digastric.

2d. Gustatory Branch.

The gustatory nerve passes downward and forward, first behind the external pterygoid muscle, then between the pterygoid muscles and then between the internal pterygoid and ramus of the lower jaw, and reaching the side of the tongue splits into many filaments to supply the anterior part of that organ. While between the two pterygoid muscles it receives at an acute angle the chorda tympani nerve, a branch of the seventh nerve, which it transmits to the submaxillary ganglion of the sympathetic. Beneath the tongue the gustatory gives off a branch of communication to the twelfth.

3d. Auriculo-Temporal.

The auriculo-temporal branch arises by two roots. It first passes backward behind the articulation of the lower jaw, then ascends between the meatus auditorius externus and condyle of the lower jaw and emerging from beneath the parotid gland divides into branches called anterior and

posterior temporal which supply the integument of the temporal region. It gives off branches to the articulation of the lower jaw, to the parotid gland, to the pinna, to the meatus auditorius and two communicating branches to the facial nerve.

Sixth Nerve.

Gray Mass—Floor of the Fourth Ventricle.

The sixth nerve, or abducens, has its apparent origin from the upper constricted portion of the medulla just behind the pons Varolii and advances along the inner wall of the cavernous sinus to enter the orbit through the anterior foramen lacerum and be distributed, often passing between its two heads, to the ocular face of the external rectus muscle.

Seventh Nerve.

The seventh, or facial, nerve (the motor nerve of the face) is the uppermost of the five nerves which spring from the groove between the corpora olivare and restiformia. Just beneath it, in the same groove, is another nerve called the portio intermedia which unites with it. If this be counted as a separate nerve, it may be said that there are six nerves springing successively from this groove. It makes for the internal auditory meatus which it enters in company with the auditory nerve; and when the two reach the bottom of the canal the facial parts from its companion and enters another canal in the petrous bone called the aqueduct of Fallopius, which conducts it first outward, then backward and then downward to the stylo-mastoid foramen, emerging from which it passes forward through the parotid gland, over the external carotid artery, and divides into numerous branches which are distributed to all the muscles of the face except those of mastication, and of these the buccinator gets a branch.

Branches.

Besides its terminal filaments on the face, the facial gives off the following branches:

1st. Auditory, which is furnished the auditory nerve while the facial is in the internal auditory meatus.

2d. Tympanic, which arises from the facial while it is in the aqueduct of Fallopius and is distributed to a muscle of the tympanic cavity.

3d. Chorda tympani, which is emitted from the facial just above the

stylo-mastoid foramen and first ascends through the petrous bone and enters the tympanium at the base of the pyramid on its posterior wall, then crosses on the inner surface of the membrana tympani and leaves through the fissure of Glaser, having emerged from which it joins the gustatory branch between the two pterygoid muscles and continues with it to the submaxillary ganglion.

After emerging from the stylo-mastoid foramen, the facial gives off the following branches:

4th. Stylo-hyoid, which supplies the stylo-hyoid muscle.

5th. Digastric, which is distributed to the posterior belly of the digastric muscle.

6th. Posterior auricular, which ascends behind the ear and after communicating with the auricular branch of the pneumogastric is distributed by an anterior branch to the auricle and by a posterior to the back of the head.

Besides the foregoing the facial has numerous communicating branches. Three of these proceed from a gangliform swelling of the nerve called the intumescentia gangliformis, situated at the hiatus Fallopii. They are the nervus petrosus superficialis major to Meckel's ganglion and the nervus petrosus superficialis minor to the otic ganglion and the external petrosal to the carotid plexus.

After emerging the facial nerve communicates with the glosso-pharyngeal, and the auricularis magnus from the cervical plexus and receives two large branches from the auriculo-temporal.

Eighth Nerve.

Floor of the Fourth Ventricle.

The eighth nerve, or portio mollis, or auditory, is the second of the nerves arising from the groove between the corpora olivare and restiforme. It passes forward and enters, along with the seventh, the internal auditory meatus, at the bottom of which it divides into a cochlear and three vestibular branches, which are distributed to corresponding parts of the labyrinth.

Ninth Nerve.

Floor of the Fourth Ventricle.

The ninth nerve, or glosso-pharyngeal, is the third nerve arising in the groove between the corpora olivare and restiforme. It escapes from the cranium, along with the tenth and eleventh, through the posterior fora-

men lacerum, lying behind the internal carotid artery; it then passes forward between the artery and the internal jugular vein to the outer side of the artery, then crosses the artery in front of thc posterior border of the stylo-pharyngeus, and then crosses that muscle to be distributed by its terminal filaments to the mucous membrane of the posterior part of the tongue.

Branches.

Besides its terminal branches the ninth nerve gives off four branches of distribution. While in the jugular foramen the nerve presents two gangliform enlargements. The uppermost of these, small and unimportant, is called the jugular ganglion; while the lower is large and is called the petrous ganglion. From the latter there is one branch of distribution given off to the tympanum.

1st. The tympanic branch passes to the tympanum through a canal which opens on the ridge of bone between the carotid and jugular foramina. After reaching the tympanum it is distributed by six branches, as follows:

(*a*) One to the lining membrane of the tympanum and Eustachian tube.

(*b*) One to the fenestra rotunda.

(*c*) One to the fenestra ovalis.

(*d*) One to the carotid plexus of the sympathetic.

(*e*) One to the great superficial petrosal nerve.

(*f*) One to the lesser superficial petrosal nerve.

2d. A muscular branch which supplies the stylo-pharyngeus, posterior belly of the digastric and the stylo-hyoid.

3d. The pharyngeal branches, which are found on the posterior part of the pharynx aiding to form a plexus called the pharyngeal from which the pharynx is supplied. The other nerves entering into the formation of this plexus are the pharyngeal and superior laryngeal of the tenth and the sympathetic.

4th. The tonsillar branches which form a plexus on the tonsils.

The branches of communication of the ninth nerve are as follows:

1st. One to the ganglion of the tenth nerve.

2d. One to the superior cervical ganglion of the sympathetic.

3d. One to the seventh nerve.

4th. Carotid filaments which descend with the carotid artery.

Tenth Nerve.

Floor of the Fourth Ventricle.

The tenth nerve, or pneumogastric, or par vagum, is the fourth nerve arising from the groove between the corpora olivare and restiforme. It escapes from the cranium through the jugular foramen and descends the neck, enters the thorax through which it passes along with the œsophagus and gains the abdomen where it is found running from left to right along the lesser curvature of the stomach. In the neck the course and relations of the nerve are the same on both sides, *i. e.*, the nerve lies first between the internal jugular vein and the internal carotid artery, then between the internal jugular vein and common carotid artery until it reaches the root of the neck and the relations thenceforward vary according to the side. The right nerve at the root of the neck crosses the first portion of the subclavian artery, enters the chest, reaches the posterior aspect of the root of the right lung; descends thence along the posterior aspect of the œsophagus to the stomach and runs along the lesser curvature of that organ, being distributed by its terminal filaments to its posterior face. The left enters the thorax lying on the front of the first portion of the left subclavian, crosses the front of the arch of the aorta, reaches the posterior aspect of the root of the left lung and thence passes down the front of the œsophagus to the stomach, runs along its lesser curvature and is distributed to its anterior face. While in the jugular foramen the nerve presents a gangliform enlargement called the ganglion of the root, and about half an inch below this a second and larger one called the ganglion of the trunk.

Branches.

Besides the terminal or gastric branches, its branches of distribution are as follows:

1. Pharyngeal.

The pharyngeal branch arises from the ganglion of the root and descends to the posterior aspect of the pharynx to aid in forming the pharyngeal plexus.

2. Superior Laryngeal.

The superior laryngeal branch arises from the ganglion of the trunk and descending pierces the thyro-hyoid membrane and is distributed to

the mucous membrane of the larynx, giving a filament to the arytenoid muscle. Just below the thyro-hyoid membrane it gives off a branch, called the external laryngeal, which is distributed to the thyroid gland and crico-thyroid muscle and furnishes some filaments to the pharyngeal plexus.

3. Recurrent Laryngeal.

The recurrent or inferior laryngeal branch arises at a different point on each side; on the left it arises as the pneumogastric is crossing the aorta and winds backward around the aorta; on the right it arises as the nerve is crossing the first portion of the subclavian and winds around that artery. After its origin each nerve ascends in the groove between the trachea and œsophagus, giving filaments to those parts, and is distributed to all the muscles of the larynx except the crico-thyroid.

4. Posterior Pulmonary.

The posterior pulmonary branches form an intricate plexus on the back of the root of the lung, whence filaments are sent along the bronchial tubes into the lungs.

5. Anterior Pulmonary.

The anterior pulmonary branches form a smaller plexus on the front of the root of the lung.

6. Œsophageal.

The œsophageal branches are filaments furnished the œsophagus before the nerves are in relation with it.

The two nerves communicate frequently around the tube, surrounding it with numerous anastomoses, thus forming the œsophageal plexus.

7. Cardiac.

The cardiac branches are numerous. They arise in the upper part of the neck, the lower part of the neck, the thorax and from the recurrent laryngeal nerve and are destined for the heart.

The communications of the pneumogastric are as follows: The ganglion of the root communicates with the ninth and eleventh nerves and with the superior cervical ganglion of the sympathetic, besides which it gives off an unimportant branch called the auricular which joins the facial

nerve in the aqueductus Fallopii. The ganglion of the trunk communicates with the twelfth nerve and with the loop between the first and second cervical nerves.

Eleventh Nerve.

The eleventh nerve, or spinal accessory, is the fifth nerve arising in the groove between the corpora olivare and restiforme and escapes from the cranium through the posterior foramen lacerum along with the ninth and tenth nerves. The nerve consists of two portions: 1st, a cranial or accessary portion which arises from the groove mentioned and, after communicating with the cervical portion, goes to the pneumogastric; 2d, a spinal portion which arises by successive filaments from the side of the spinal cord as low as the sixth cervical nerve and ascends between the two roots of the spinal nerves. It enters the cranium through the foramen magnum and after communicating with the accessory portion emerges through the jugular foramen, passes downward and outward, pierces the sterno-cleido-mastoid muscle and reaches the trapezius to which it is distributed, giving, on its way, filaments to the sterno-cleido-mastoid. The two portions of this nerve are never closely united, but after the spinal portion has ascended to the cranium several communicating branches pass between them.

Twelfth Nerve.

The twelfth nerve, or hypoglossal, arises from the groove between the corpora olivare and pyramidale by ten or twelve filaments which are gathered into two bundles: these pass outward and, just as they are leaving the cranium through the anterior condyloid foramen, unite to form the trunk of the nerve. The nerve then descends between the internal jugular vein and internal carotid artery and, when it reaches a point on a level with the jaw, curves forward in front of both internal and external carotid arteries, and after communicating with the gustatory nerve is distributed to the muscles of the tongue.

Branches.

The branches of distribution, besides the terminal, are two, the descendens noni, a very important branch, and the thyro-hyoidean of small importance.

1st. Descendens Noni Nerve.

The descendens noni leaves the hypoglossal just as it is crossing the

external carotid artery and derives its name from its direction and from the fact that the twelfth nerve was, in Willis' classification, called the ninth. It passes down the neck on the front of the sheath of the external, carotid artery, and then on the sheath of the common carotid, occasionally descending in the sheath. About the middle of the neck it anastomoses with filaments from the second and third cervical nerves, the communicans noni, forming what is called the arch of Scarpa, which lies in front of the sheath of the common carotid artery about the middle of the neck. From this arch branches are given to the depressor muscles of the hyoid bone, except the thyro-hyoid.

2. Thyro-Hyoidean.

The thyro-hyoidean branch descends from near the termination of the hypoglossal nerve to supply the thyro-hyoid muscle.

The Spinal Cord.

The spinal cord, or marrow, or medulla spinalis, is that portion of the cerebro-spinal axis which is found in the spinal canal. In the adult it does not extend the whole length of the canal, but, beginning at the foramen magnum, terminates in a pointed extremity at the lower border of the body of the first lumbar vertebra, from which point the canal is occupied by nerves to which the cord has given birth. In the young subject the cord reaches the whole length of the canal, but as development advances the canal increases in length much faster than the cord.

The spinal marrow, like the brain, is enveloped by three membranes, dura mater, arachnoid and pia mater, which are continuous with similar membranes of the brain. The dura mater of the cord, however, is not adherent to the interior of the wall of the canal but is separated from it by a considerable interval, the wall being provided with a proper periosteum.

The spinal cord is composed of white matter externally and gray matter within, and is marked down its middle, both in front and behind, by grooves called anterior and posterior median fissures, the posterior being much the deeper. The lateral halves of the cord, thus divided, are connected by a band whose thickness is measured by the interval between the bottom of the two median fissures. The front and back of this band are made up of white fibres and are called the white commissures of the cord; but in the centre the band is gray and is called the gray commissure. The white commissure connects the white matter on the exterior

of each lateral half and the gray commissure, the gray matter of the interior. This gray matter is placed in the interior of each half in a crescentic form, the convexity of the crescent looking towards the opposite half and receiving the gray commissure while the horns of the crescent pass, the anterior outward and forward, and the posterior outward and backward in the white matter, the posterior horn coming nearer the surface than the anterior. Each lateral half of the spinal cord is marked by two longitudinal fissures which are much less marked than the anterior and posterior median fissures: thus each lateral half is subdivided into three columns by the grooves known as the antero-lateral and postero-lateral sulci, in contra-distinction to the median fissures.

THE SPINAL NERVES.

Emerging from each lateral aspect of the spinal marrow, and proceeding as the result of its termination, are nerves called the spinal nerves. There are thirty-one pairs of these, consisting of two exactly similar nerves placed one on each side. A spinal nerve arises by two roots, one from the antero-lateral sulcus of the cord called its anterior or motor root, the other from the postero-lateral sulcus and called the posterior or sensory root. Soon after its origin the posterior root presents a gangliform enlargement immediately after the formation of which the two roots combine to form the nerve which escapes from the spinal canal through an inter-vertebral foramen, except the first nerve which makes its exit between the atlas and occipital bone, and the last two which leave the canal through the aperture at the lower extremity of the sacrum.

The thirty-one pairs are arranged in groups named from the region of the spine in which they emerge. Thus:

Cervical nerves, consisting of the first eight pairs.

Dorsal nerves, consisting of the next twelve pairs.

Lumbar nerves, consisting of the next five pairs.

Sacral nerves, consisting of the next six pairs.

It is sometimes said that the last six pairs consist of five sacral and one coccygeal.

Immediately after each nerve has emerged from the spinal canal it divides into two branches or cords, one, the posterior, intended to supply the structures of the back, and as these are of small importance the posterior cords will be no further considered. The other branches, called the anterior cords, are of vast importance as they supply all the structures on the front of the body and the extremities. In all the regions of the spine, except the dorsal, the nerves before proceeding to their distribution inter-communicate and form separate intricate net-works in the various regions called plexuses, from which branches pass to supply the parts for which the nerves are intended. Four or five nerves usually unite to form a plexus. The first plexus formed by the spinal nerves is the cervical.

The Cervical Spinal Nerves.

The cervical nerves are eight pairs, the anterior cords of which go, for the upper four, to the cervical plexus, and the lower four the brachial plexus. The posterior cords go to the structures at the back of the neck.

The Cervical Plexus.

The cervical plexus is formed by the intercommunication of the anterior cords of the four upper cervical nerves, and is found beneath the middle of the sterno-cleido-mastoid muscle. Its principal distribution is to the muscles and integument of the neck. The branches are divided into a superficial set to the skin and a deep set to muscles.

The superficial branches are the four following:

I. Superficialis Colli.

Second and Third Cervical.

The superficialis colli emerges around the posterior border of the sterno-cleido-mastoid muscle about its middle and runs forward and upward on that muscle to be distributed to the integument of the front of the neck as high as the chin giving off in its course a descending branch.

II. Auricularis Magnus.

Second and Third Cervical.

The auricularis magnus branch comes out about the middle of the posterior border of the sterno-cleido-mastoid muscle, ascends on that muscle and is distributed by two branches to the front and back of the ear, having giving off filaments to the skin in its course.

III. Occipitalis Minor—of Second Cervical.

The occipitalis minor branch ascends parallel with the posterior border of the sterno-cleido-mastoid muscle and is distributed on the side of the head behind the ear as high as the vertex.

IV. Descending Superficial Branches of Third and Fourth.

The descending superficial branches supply the integument of the lower part of the neck and crossing the clavicle terminate in the integument of

the upper part of the thoracic wall from the sternum to the acromion process. These branches are sometimes divided into three sets, sternal, clavicular and acromial, the names indicating the direction of the fibres.

The deep branches of the plexus are three, as follows:

I. Muscular Branches.

The muscular branches supply the prævertebral group of muscles, *i. e.*, all the muscles of the neck except the depressors of the hyoid bone.

II. Communican's Noni.

The communican's noni is formed by filaments from the second and third nerve, and curving downward and forward communicates with the descendens noni, forming Scarpa's arch, on the front of the sheath of the common carotid, from which filaments supply the depressor muscles of the hyoid bone, except the thyro-hyoid.

III. The Phrenic Nerve.

The phrenic nerve is formed by contributions from the third and fourth cervical nerves and these, after descending a short distance, are reinforced by a filament from the fifth. The course of the nerve on the two sides is different. Descending on the front of the scalenus anticus muscles on the right side it generally slips to the inner side of that muscle and crosses in front of the first portion of the right subclavian artery, between it and its vein, and continues its downward course in the thorax, beside the right vena innominata and the superior vena cava, passes in front of the root of the right lung, thence onward between the pleura and pericardium and finally pierces the diaphragm and is distributed to it from its under surface. The left nerve differs from this in but two particulars, it enters the chest lying on the first portion of the subclavian artery and then crosses the arch of the aorta, its course thence being the same as the right, except that it has no relation to the left vena innominata or the superior vena cava. Occasionally the right nerve does not get to the inner side of the scalenus anticus muscle until it has passed the subclavian, in which case it crosses the second portion of that artery.

Brachial Plexus.

The brachial or axillary plexus is the second, formed by the anterior cords of the spinal nerves. It is the result of the inter-communications

between the four lower cervical nerves (fifth, sixth, seventh and eighth) and the greater portion of the first dorsal. The manner of its formation is as follows: the fifth and sixth cervical unite at once, and the cord thus formed is soon joined by the seventh cervical; the eighth cervical and first dorsal unite to form one cord, and thus at one time there are but two cords in the plexus, but soon these two each give off a branch, and these branches unite to form a third cord. The course of the plexus is downward and outward; it first lies between the two scaleni muscles and then lies in relation with the second and third portions of the subclavian artery above and to its outer side; it then comes into relation with the axillary artery, lying first to its outer side, then to the outer side and behind, then to the outer side, behind and to the inner side, and finally, the two lateral cords each produce a branch and these unite over the front of the artery to form the median nerve and the artery is entirely enveloped. The median is formed on the front of the commencement of the third portion of the axillary, and the plexus here breaks up into its terminal branches. This point about corresponds to the coracoid process of the scapula.

Branches.

The distribution of the brachial plexus is chiefly to the upper extremity' supplying its muscles and skin; but before reaching the upper extremity it gives off some muscular branches. The branches of the plexus are divided into two sets, muscular and terminal.

Muscular Branches.

As the brachial plexus is crossing with the subclavian and axillary arteries it gives off numerous filaments to neighboring muscles, viz: the scaleni, rhomboid and subclavius, which are collectively known as the superior muscular branches. Besides these there are other muscular branches bearing specific names, as follows:

Supra–Scapular Branch.

The supra-scapular branch arises from the outer cord, passes outward to gain the dorsum of the scapula, through the supra-scapular notch, and be distributed to the supra and infra spinati.

Anterior Thoracic Nerves.

The anterior thoracic nerves arise the one from the outer and the other

from the inner cord, and after forming a loop of communication over the axillary artery are distributed to the pectoral muscles.

Posterior Thoracic Nerve.

Fifth and Sixth Cervical.

The posterior thoracic nerve, or external respiratory, is the nerve for the serratus magnus muscle. It is formed by a filament from the fifth and another from the sixth cervical nerves, and descending behind the axillary vessels is distributed to the serratus magnus.

Subscapular Branches.

Posterior Cord.

The subscapular are three branches which go to the subscapularis, teres major and latissimus dorsi muscles.

Terminal Branches.

The terminal branches of the plexus are seven in number, as follows: musculo-cutaneous, internal cutaneous, lesser internal cutaneous, median ulnar, musculo-spiral and posterior circumflex. They arise in the following manner: the internal cord produces the internal cutaneous, lesser internal cutaneous, ulnar and one head of the median, the external cord produces the musculo-cutaneous, and one head of the median, the posterior cord gives rise to the musculo-spiral and posterior circumflex.

I. Musculo-Cutaneous Nerve.

The musculo-cutaneous pierces the coraco-brachialis and passes downward and outward between the biceps and brachialis anticus muscles to become superficial at the outer side of the front of the elbow, where it divides into two cutaneous branches (external cutaneous) which are distributed to the integument of the outer side and outer portion of the front of the forearm as far as the wrist. Besides its terminal distribution it supplies the coraco-brachialis, biceps and brachialis anticus muscles.

II. Internal Cutaneous Nerve.

The internal cutaneous nerve descends to the inner side of the axillary and brachial arteries and about the middle of the arm pierces the deep

fascia to become superficial and divides into branches which are distributed to the inner side and inner part of the front of the forearm as far as the wrist. It gives filaments also to supply the integument of the front of the arm.

III. Lesser Internal Cutaneous Nerve.

The lesser internal cutaneous nerve, or nerve of Wrisberg, descends the inner side of the arm and divides into filaments which are lost in the integument of the lower third of the posterior aspect of the arm. It is the smallest of the terminal branches of the plexus and is soon exhausted. It communicates with the lateral cutaneous branch of the second intercostal nerve, or intercosto-humeral.

IV. Median Nerve.

The median nerve arises by two roots, one from each lateral cord of the plexus, which unite in front of the axillary artery just in front of the pectoralis minor muscle. It descends first to the outer side of the axillary, then to the outer side of the brachial artery, and then crossing the brachial about the middle of the arm, usually in front, it passes to the inner side of the brachial, which relation it maintains to the elbow when it first earns the name median, being here for the first time in the middle of the limb. From its origin to the elbow it is superficial; entering the forearm it becomes deep, for passing into it between the two heads of the pronator radii teres, it descends the forearm beneath the flexor sublimis digitorum and enters the palm of the hand beneath the anterior annular ligament where it divides into terminal branches which are distributed as follows: two to supply the sides of the palmar aspect of the thumb, one to the radial side of the index finger, one which divides to supply adjacent sides of the index and middle fingers, one for the adjoining sides of the ring and middle fingers and a muscular branch which supplies the following muscles of the thenar eminence: abductor pollicis, flexor ossis metacarpi pollicis and the superficial head of the flexor brevis pollicis (*i. e.*, all the muscles arising from the trapezium and annular ligament). Until it reaches the elbow the median emits no branches. While at the elbow and lying beneath the aponeurotic slip of the biceps it produces a number of muscular branches which supply all the muscles of the front of the forearm except one and a half, *i. e.*, flexor carpi ulnaris and the ulnar half of the flexor profundus digitorum, which are supplied by the ulnar nerve. The branch to the pronator quadratus descends on the

front of the interosseous membrame from the elbow and is called the anterior interosseous nerve. At the lower part of the forearm the median gives off a cutaneous branch which descends in front of the anterior annular ligament to the skin of the palm.

V. Ulnar Nerves.

The ulnar nerve descends at first to the inner side of the axillary and brachial arteries, but as it passes down the inner side of the arm it diverges from the brachial artery, making for the inner side of the back of the elbow where it lies in the groove between the internal condyle and the olecranon, forming what is called the funny bone. It enters the forearm between the two heads of the flexor carpi ulnaris muscle and at the commencement of the middle third of the forearm comes into relation with the ulnar artery and, lying to the inner side of that vessel, enters the palm of the hand and divides into a superficial and a deep palmar branch. The superficial palmar branch supplies the palmaris brevis, the integument of the inner side of the hand and then divides into two branches, one of which supplies the inner side of the little finger and the other, after giving off a communication to the median, divides to supply the adjacent sides of the little and ring fingers. The deep branch disappears between the abductor minimi digiti and flexor brevis minimi digiti and supplying the muscles of the hypothenar eminence passes across the palm with the deep palmar arch and is distributed to one muscle and a half of the thenar eminence, adductor pollicis and deep head of the flexor brevis pollicis. On the forearm the ulnar nerve emits the following branches:

1st. Muscular branches to the flexor carpi ulnaris and the ulnar half of the flexor profundis digitorum.

2d. An unimportant cutaneous branch which descends superficially into the palm to be lost in the skin.

3d. A dorsal cutaneous branch which arises about two inches above the wrist and passes backward beneath the tendon of the flexor carpi ulnaris muscle to the dorsum of the hand where it communicates with the radial nerve and divides into branches which supply the integument of the inner portion of the dorsum and two fingers and a half, viz: the little and ring fingers and the ulnar side of the middle finger.

VI. Musculo-Spiral Nerve.

The musculo-spiral springs from the posterior cord of the brachial plexus, and is the largest cord of that plexus. It passes downward and

outward behind the humerus between it and the triceps muscle, lying in the musculo-spiral groove on the posterior surface of the humerus, until it reaches the space between the spinator longus and brachialis anticus and then descends to the outer side of the front of the elbow, where it divides into two branches, radial and posterior interosseous. Besides its two terminal branches the musculo-spiral gives off cutaneous branches which supply one the front and one the back of the arm and one the back of the forearm. It also gives branches to the following muscles: triceps, brachialis anticus, supinator longus, extensor carpi radialis longior and anconeus.

1. The Radial Nerve.

The radial nerve, derived from the musculo-spiral at the outer side of the front of the elbow, descends the radial side of the front of the forearm lying at first too remotely to the outer side of the radial artery to be considered a relation of it, but coming into relation with it at the middle third of the forearm and lying to its outer side until it reaches the lower third, about three inches above the wrist, when it seeks the back of the forearm by passing beneath the tendon of the supinator longus and divides into an outer branch, which supplies the two sides of the thumb, and an inner branch, which supplies the index finger and radial side of the middle finger. The radial nerve communicates with the dorsal branch of the ulnar on the dorsum of the hand.

2. Posterior Interosseous Nerve.

The posterior interosseous branch of the musculo-spiral immediately pierces the supinator brevis muscle to reach the back of the forearm and then descends between the superficial and deep layers of muscles, being distributed to all the muscles of the back of the forearm except the three supplied by the musculo-spiral, supinator longus, extensor carpi radialis longior and anconeus.

VII. Posterior Circumflex Nerve.

The posterior circumflex nerve, arising from the posterior cord of the brachial plexus, winds around behind the surgical neck of the humerus, in company with the posterior circumflex artery, and is distributed by an upper branch to the deltoid muscle, and by a lower branch to the teres minor and the integument covering the shoulder.

Dorsal Spinal Nerves.

The dorsal spinal nerves are twelve pairs, the posterior branches of which are distributed to the structures of the back, while the anterior cords form the intercostal nerves, and, unlike other spinal nerves, do not form a plexus but are distributed separately.

The Intercostal Nerves.

The intercostal nerves are the anterior cords of the twelve dorsal nerves, and derive their name from their course forward between the ribs. The first dorsal nerve sends almost all its bulk to the brachial plexus, and the twelfth usually given a branch to the lumbar plexus. The intercostal nerves are intended for the supply of the muscles among which they course, and of the integument of the front and sides of the thorax and abdomen. Each intercostal nerve runs forward in the intercostal space between the intercostal muscles to near the edge of the sternum where it turns forward and becomes superficial, being called the anterior cutaneous. It is then distributed to the integument of the front of the chest and abdomen, most of the filaments passing outward in a recurrent course. The six upper nerves appear as the anterior cutaneous through the corresponding intercostal spaces, while the six lower pierce the sheath of the rectus muscle, and are called the anterior cutaneous of the abdomen. After reaching the extremities of the intercostal spaces these last nerves pass on between the broad muscles of the abdomen, and the last one, though called intercostal, is really not one since it lies below the last rib. Whilst running forward the intercostal nerves supply the intercostal muscles and the broad muscles of the abdomen, and about midway its course each nerve gives off a branch called lateral cutaneous, which divides into two, one branch passing forward and the other backward, both being distributed to the integument of the side of the chest or abdomen. The first intercostal nerve, owing to the fact that most of the cord from which it is derived goes to the brachial plexus, gives off no lateral branch, and to compensate for this delinquency the lateral cutaneous branch of the second nerve is remarkably large, and not only fulfils the office of the lateral cutaneous branches for itself and the first, but under the name of intercosto-humeral, passes into the axilla, where it communicates with the lesser internal cutaneous. The lateral cutaneous branch of the twelfth nerve descends over the crest of the ilium, and is distributed to the integument of the gluteal region.

The Lumbar Spinal Nerves.

The lumbar spinal nerves are five pairs, the posterior cords of which supply the structures of the back in their region, while the anterior cords have the following disposition: The upper four, usually with a branch from the twelfth dorsal, constitute by their communication the lumbar plexus. The fifth, having been joined by the communicating branch from the lumbar plexus, descends into the pelvis (under the name of lumbo-sacral cord) to join the sacral plexus.

The Lumbar Plexus.

The lumbar plexus is formed by the intercommunication of the anterior cords of the four upper lumbar nerves, usually aided by a branch from the twelfth dorsal. It lies entangled in the back part of the psoas magnus muscle and behind that muscle. It is distributed to all of the thigh, except the posterior femoral region, to the inner side of the leg and foot and to the lowest part of the anterior abdominal parietes, by the following branches: ilio-hypogastric, ilio-inguinal, external cutaneous, anterior crural, genito-crural, obturator and a communicating branch to the sacral plexus. Although this is the order in which the branches spring from the plexus from above downward, it will be more convenient to describe them in a somewhat different order. The first three branches have a course outward and downward, one above the other, across the posterior wall of the abdomen and disappear from it on its lateral aspect.

I. Ilio-Hypogastric Nerve.

First Lumbar.

The ilio hypogastric branch passes outward across the quadratus lumborum muscle to pierce the transversalis muscle, and run forward piercing successively the internal and external oblique to become cutaneous just above the external abdominal ring, beside the linea alba, and be distributed to the integument of the hypogastric region, having furnished on its route branches to the broad muscles of the abdomen and given off a branch called iliac, which descends over the crest of the ilium to supply the skin of the hip.

II. Ilio-Inguinal Nerve.

First Lumbar.

The ilio-inguinal passes outward parallel with and a little below the ilio-hypogastric to pierce the transversalis and the internal oblique and, thus gaining the external abdominal ring, escape to supply the integument of the scrotum and upper part of the inner aspect of the thigh. On its way it gives branches to the broad muscles of the abdomen and communicates with the ilio-hypogastric.

III. External Cutaneous Nerve.

Second and Third Lumbar.

The external cutaneous nerve passes downward and outward, across the iliacus internus muscle, to escape into the thigh through the notch below the anterior superior spinous process of the ilium, where, after a course of a few inches in the thickness of the fascia lata, it becomes superficial and is distributed to the integument of the outer front aspect of the thigh, by a posterior branch encroaching on the back of the thigh.

IV. Genito-Crural Nerve.

First and Second Lumbar.

The genito-crural branch pierces the psoas magnus muscle from behind forward and then runs down on the front of that muscle to divide just above Poupart's ligament into two branches, genital and crural. The genital branch enters the internal abdominal ring and descends along the spermatic canal to be lost in the cremaster muscle or round ligament. The crural branch passes beneath Poupart's ligament to be distributed to the integument of the front of the thigh as far as the middle.

V. Obturator Nerve.

Third and Fourth Lumbar.

The obturator nerve passes forward just below the brim of the pelvis, in company with the obturator artery, to escape through the upper part of the obturator foramen, grooving the under surface of the pubes, and divides into an anterior and a posterior branch, which are distributed to

the three adductors and the pectineus and to the obturator externus. The posterior branch lies behind the adductor brevis; the anterior descends in front of that muscle and is distributed to the integument of the inner side of the thigh, furnishing filaments to a plexiform communication of different nerves over the front of the lower part of the femoral artery, called the femoral plexus.

VI. Anterior Crural Nerve.

Second, Third and Fourth Lumbar.

The anterior crural is the largest branch of the lumbar plexus. It descends in the interval between the iliacus internus and psoas magnus muscles and entering the thigh beneath Poupart's ligament lies about one-fourth or one-half of an inch to the outer side of the femoral artery. Almost immediately upon entering the thigh it splits into branches which may be divided into two sets, a superficial or cutaneous set and a deep or muscular set. The cutaneous branches are middle cutaneous, internal cutaneous and internal saphenous.

1. Middle Cutaneous Branches.

The middle cutaneous branches are distributed to the integument of the front of the thigh to the knee, one or more of them piercing the sartorius and giving filaments to it.

2. Internal Cutaneous Branch.

The internal cutaneous branch passes inward over the femoral artery and divides into an anterior and a posterior branch, which are distributed to the integument of the inner front aspect of the thigh as far as the knee. The posterior branch descends along the posterior edge of the sartorius muscle and pierces the fascia lata about the knee. The anterior branch becomes superficial about the lower third of the thigh.

3. Internal Saphenous Branch.

The internal or long saphenous nerve descends in close contact with the outer side of the sheath of the femoral vessels until it reaches Hunter's canal, when it becomes superficial to them; it then descends between the sartorius and gracilis muscles, and continues its course down the inner side of the leg in front of the ankle and along the inner side of

the foot as far as the great toe, being distributed to the integument of the inner side of the leg, inner side of the foot and inner side of the great toe.

The long saphenous furnishes filaments to the femoral plexus, the elements of which are derived from it, from the obturator and from the internal cutaneous. Just above the knee the long saphenous gives off a branch called the cutaneus patellae, which is joined by filaments from the external, middle and internal cutaneous nerves, to form an intricate intercommunication over the front of the patella called the plexus patellae.

Muscular Branches.

The muscular branches of the anterior crural are distributed to the anterior femoral muscles, *i. e.* rectus, and two vasti and sometimes the pectineus. The sartorius is supplied by the middle cutaneous branches as these pierce it, and the tensor vaginæ femoris is supplied by the gluteal branch of the sacral plexus.

VII. Communicating Branch.

The communicating branch joins the anterior cord of the fifth lumbar and descends into the pelvis to aid in forming the sacral plexus, by the name of lumbo-sacral.

The Sacral Plexus.

The sacral plexus is formed by the fusion of the lumbo-sacral nerve with the three anterior cords of the three upper sacral nerves with half the anterior cord of the fourth sacral. This plexus differs from others in this, that it is not a simple intercommunication, but the elements blend into a broad continuous band. The plexus extends from its base formed by its roots downward and outward to the great sacro-sciatic foramen, where it breaks up into its four terminal branches. It lies on the lateral front face of the sacrum and on the front of the pyriformis muscle. The distribution of the plexus is to the viscera and walls of the pelvis, to the gluteal region, to the posterior femoral region of the thigh, to all the leg except the inner side, to all the foot except the inner side, and to all the toes except the inner side of the great toe.

Branches.

Besides its four terminal branches the sacral plexus produces a set of visceral branches to the pelvic viscera, which are in part supplied by

branches derived from that portion of the fourth sacral nerve which does not enter into the plexus, and a second set to muscles, viz: the levator ani and all the outward rotators of the thigh, except the obturator externus, which gets its supply from the obturator nerve. The four terminal branches of the plexus are superior gluteal, internal pudic, lesser and greater sciatic.

I. Gluteal Nerve.

The superior gluteal nerve comes off from the upper part of the sacral plexus and leaves the cavity of the pelvis through the greater sacro-sciatic foramen, above the pyriformis muscle, and divides into two branches, which ramify between the gluteus medius and minimus, being distributed to those two muscles and by terminal filaments to the tensor vaginæ femoris.

II. Internal Pudic Nerve.

The internal pudic nerve arises from the lower part of the plexus and leaves the pelvis through the greater sacro-sciatic foramen, below the pyriformis muscle, crosses the spine of the ischium and re-enters the pelvis through the lesser sacro-sciatic foramen, dividing into two branches, a superior, or dorsalis penis, and an inferior, or perineal, having emitted before dividing the inferior hemorrhoidal branch, which is distributed to the sphincter ani and the integument around the anus.

1. Dorsalis Penis Nerve.

The dorsalis penis branch passes upward and forward along the ramus of the ischium and pubes, pierces the suspensary ligament of the penis, continues its course forward on the dorsum of the penis, supplying the integument and corpus cavernosum and terminates in the glans penis. It gives off a lateral cutaneous branch to the side of the organ.

2. Perineal Nerve.

The perineal branch divides into two sets of branches, cutaneous and muscular. The cutaneous branches are two, anterior and posterior, and pass forward being distributed to the integument of the scrotum, perineum and under surface of the penis. The muscular branches are directed to the muscles of the perineum, viz: tranversus perinei, erector penis, accelerator urinæ and compressor urethræ. Several of the deep filaments also supply the corpus spongiosum.

III. Lesser Sciatic Nerve.

The lesser sciatic nerve, usually arising by two roots, escapes through the greater sacro-sciatic foramen below the pyriformis muscle along with but superficial to the great sciatic nerve, and descends the middle of the back of the thigh beneath the fascia lata to terminate on the back of the upper part of the leg.

Branches.

The branches of the lesser sciatic are chiefly cutaneous but it supplies one muscle, the gluteus maximus. The cutaneous distribution comprises the filaments distributed to the integument in the downward course of the nerve on the back of the thigh and upper part of the back of the leg, and may be called descending cutaneous branches. Secondly, it sends cutaneous branches upward to the integument of the lower portion of the gluteal region, and these are known as ascending cutaneous branches. Thirdly, it gives off internal or perineal cutaneous branches which supply the integument along the inner posterior aspect of the thigh; one of these is known as the inferior pudendal nerve which curves upward and forward to communicate with the perineal branch of the internal pudic, and aid in supplying the integument of the perineum.

IV. Great Sciatic Nerve.

The great sciatic is the longest nerve in the system and seems a continuation of the plexus through the great sacro-sciatic foramen, below the pyriformis muscle, being the last structure which has to be traced through that aperture. These structures are eight in number of which the pyriformis muscle is the bulkiest, almost filling the foramen. Besides it there are four nerves and three arteries which emerge through the foramen, one artery and one nerve passing above the muscle, viz: the gluteal artery and nerve, and two arteries and three nerves passing below, viz: the internal pudic and ischiatic arteries and the greater and lesser sciatic and internal pudic nerves.

After escaping the great sciatic descends the middle of the back of the thigh, lying on the adductor magnus muscle beneath the biceps which separates it from the lesser sciatic. It divides usually, at the upper angle of the popliteal space, into the internal and external popliteal nerves; but it may divide before reaching that point and its two terminal branches may even come off separately from the plexus. Before dividing it gives off branches to the posterior femoral muscles and to the adductor magnus.

1. Internal Popliteal Nerve.

The internal popliteal nerve descends through the popliteal space to pass beneath the tendinous arch of the soleus muscle and there become the posterior tibial nerve. It is a relation of the popliteal artery, lying, for the upper two-thirds of that vessel, superficial and external to it and then crossing superficially to its inner side, which relation it maintains to the termination of both.

Branches.

The internal popliteal gives off muscular branches to the triceps suræ and to the popliteus muscle, besides which it produces a cutaneous branch called the external saphenous. The branches to the popliteus run to its lower border and then turn upward to the under surface of the muscle.

The External Saphenous Nerve.

The external or short saphenous nerve descends from the internal popliteal in company with the external saphenous vein, lying first in the groove between the two heads of the gastrocnemius muscle, then beside the outer edge of the tendo Achilles and, passing behind the external malleolus, runs forward on the outer side of the dorsum of the foot to the little toe. About the middle of the back of the leg it is joined by a branch of the external popliteal called the communicans peronei. The external saphenous is distributed to the integument of the outer side of the heel, outer side of the dorsum of the foot and outer side of the little toe.

Posterior Tibial Nerve.

The posterior tibial nerve, the continuation of the internal popliteal, begins at the tendinous arch of the soleus, descends the back of the leg lying beneath the triceps suræ and terminates midway between the posterior tuberosity of the os calcis and the internal malleolus by dividing into the internal and external plantar nerves. The posterior tibial nerve is a companion of the posterior tibial artery, lying at first to its inner side, but crossing it superficially after a course of a few inches to become a continuous external relation.

Branches.

Besides its terminal branches the posterior tibial nerve gives off muscular branches to the deep layers of muscles on the back of the leg

except the popliteus and a cutaneous branch, called the internal calcanean, to the integument of the heel.

The Internal Plantar Nerve.

The internal plantar nerve runs forward between the abductor pollicis and flexor brevis digitorum and divides into four branches, which are distributed as digital branches to the inner side of the great toe, the adjacent sides of the great and second, second and third toes and the inner side of the fourth toe. Besides these the nerve emits cutaneous branches to the integument of the inner side of the sole and muscular branches to muscles in its course, viz: abductor pollicis, flexor brevis digitorum and flexor brevis pollicis. Finally, the digital branches furnish filaments to the two inner lumbricales.

The External Plantar Nerve.

The external plantar nerve takes the course of the external plantar artery, running at first outward on the musculus accessorius and then forward between the flexor brevis digitorum and abductor minimi digiti, it divides into two digital branches which supply the little toe and outer side of the fourth toe. This digital distribution is exactly similar to the ulnar nerve in the hand, while that of the internal plantar is the counterpart of the median nerve. Besides its digital branches the external plantar gives off filaments to the integument of the outer side of the sole and branches to the muscles in its course, viz: musculus accessorius, abductor minimi digiti, flexor brevis minimi digiti, two outer lumbricales and two outer interossei, sends a communication to the internal plantar and lastly gives off a branch which accompanies the plantar arch and supplies the adductor pollicis, transversus pedis and all the interosseous muscles except those in the outer metatarsal space.

2. External Popliteal Nerve.

The external popliteal nerve, very much smaller than the internal, passes outward and downward from its origin as one of the terminal branches of the great sciatic, and crossing the outer head of the gastrocnemius muscle enters the substance of the peroneus longus and just below the head of the fibula divides into two branches, anterior tibial and musculo cutaneous.

Branches.

Besides the terminal branches, the external popliteal emits cutaneous

filaments to supply the integument of the outer side of the leg, and a communicating branch to the external saphenous which is called communicans peronei.

Communicans Peronei.

The communicans peronei leaves the external popliteal near the head of the fibula and crossing downward and inward on the back of the leg joins the external saphenous about the middle of the leg, having given filaments to the integument in its course.

Anterior Tibial Nerve.

The anterior tibial branch of the external popliteal nerve passes inward through the fibres of the extensor longus digitorum muscle to gain the outer side of the anterior tibial artery with which it descends the front of the leg lying first to the outer side, then in front and then again to the outer side of the artery, first on the interosseous membrane and then on the front of the tibia. Having reached the termination of the anterior tibial artery it passes forward on the dorsum of the foot lying to the outer side of the dorsalis pedis artery and where that artery terminates, at the base of the first metatarsal space, it also divides into two branches which supply the adjacent sides of the dorsal aspect of the great and second toes.

Branches.

Besides its two terminal branches the anterior tibial nerve produces muscular branches to the muscles in its course, viz: those of the anterior tibial region and the extensor brevis digitorum, the latter muscle being supplied by a branch which passes outward on the tarsus to be distributed to it and to the articulations.

Musculo-Cutaneous Nerve.

The musculo-cutaneous nerve, the second terminal branch of the external popliteal, descends in and among the muscles of the external region of the leg, lying first in the peroneus longus, then between it and the peroneus brevis and then between the two peronei and the extensor longus digitorum, and at the lower third of the outer aspect of the leg pierces the deep fascia and thus becoming superficial is distributed to the dorsum of the foot by two branches, inner and outer, not only supplying the integument of the dorsum of the foot but giving digital branches to

the adjacent sides of the second and third, third and fourth, and fourth and fifth toes, the inner branch giving off a twig which aids the internal saphenous in supplying the inner side of the great toe. Whilst coursing among the peronei it also supplies those two muscles.

Nervous Supply to the Dorsum of the Foot.

The nervous supply to the dorsum of the foot is chiefly derived from the musculo-cutaneous, but it is aided on the inner side of the dorsum and on the inner side of the great toe by the long saphenous, while the outer side of the little toe is supplied by the short saphenous, and the adjacent sides of the great and second toes are supplied by the termination of the anterior tibial.

Fourth, Fifth and Sixth Sacral Nerves.

The fourth sacral nerve sends half its bulk to aid in forming the sacral plexus. Of the other half a part goes to furnish visceral branches to the pelvic viscera and a part aids the small fifth and sixth nerves in supplying the coccygeus and levator ani muscles and the integument over the coccyx and between it and the anus.

Sympathetic Nerves.

The sympathetic nervous system consists of a vertebral and a cranial portion.

The Vertebral Portion.

The vertebral portion of the sympathetic consists of two similar series of ganglia, lying one on each side of the vertebral column, extending from the skull to the coccyx, and the nerves which are connected with these ganglia. Of these ganglia there are about twenty-four divided into cervical, of which there are three, dorsal, of which there are twelve, lumbar, of which there are four or five and sacral, of which there are about four. Each ganglion is provided with four sets of branches: 1st, ascending to connect it with the ganglion above; 2d, descending to connect it with the ganglion below; 3rd, external to connect it with a contiguous spinal nerve; 4th, internal or branches of distribution. The first three sets of branches are the communicating branches, and each of the connections, viz: with the ganglion above, the ganglion below and the spinal nerves, is effected by two filaments, one of which is gray and the other white. The fourth set of branches, the internal or distributing,

pass, as a rule, inward and forward to supply the organs of their various regions; these branches going either singly to their destination, or, as in some cases, several branches from one side meet similar ones from the opposite side and communicating with them on the front of the vertebral column, form plexuses from which the branches of distribution proceed. Three of these plexuses exist, known as the cardiac, solar and hypogastric, these constituting what is called the prævertebral sympathetic. As a rule each ganglion is connected with but one spinal nerve, but to this there are exceptions, which will be found in the cervical portion.

Cervical Portion.

The cervical portion of the sympathetic is that part of the chain or trunk which is found in the cervical region. Although there are eight cervical spinal nerves, there are only three sympathetic ganglia, known respectively as superior, middle and inferior.

Superior Cervical Ganglion.

The superior cervical ganglion lies on the front lateral aspect of the second and third cervical vertebræ, being of a fusiform shape and pinkish color.

Its external branches connect it with the first four cervical spinal nerves and also with three of the cranial nerves, viz: glosso-pharyngeal, pneumogastric and hypoglossal.

Its ascending branches pass up along the internal carotid artery, one on the inner side of that vessel to form the cavernous plexus by communications in the cavernous sinus; the other, on the outer side of the artery to form the carotid plexus.

Its descending branches connect it with the middle cervical ganglion.

This ganglion gives off branches from its front face which twine around the external carotid artery and are called nervi molles.

The internal branches, or branches of distribution, are three, as follows:

1st. Pharyngeal, which join in the pharyngeal plexus.

2d. Laryngeal, which are distributed to the larynx.

3d. Superior cardiac, distributed to the heart in a manner which will hereafter be explained. This is called the superior cardiac because each of the three cervical ganglia give off a cardiac branch which are distinguished as superior, middle and inferior.

Middle Cervical Ganglion.

The middle cervical ganglion is situated opposite the fifth cervical vertebra, is small and sometimes altogether wanting.

Its external branches communicate with the fifth and sixth cervical spinal nerves.

Its ascending and descending branches connect it with the superior and inferior cervical ganglia respectively.

Its branches of distribution are two:

1st. Middle cardiac; 2d, thyroid, which joins the inferior thyroid artery just where it makes its inward turn and accompanies it to the thyroid gland.

Inferior Cervical Ganglion.

The inferior cervical ganglion lies opposite the seventh cervical vertebra. Its external branches connect it with the seventh and eighth cervical spinal nerves.

Its ascending branches bring it into connection with the middle cervical ganglion.

Its descending branches are to the first dorsal ganglion. Its branches of distribution are as follows:

1st. Inferior cardiac; 2d, a branch which comes off from the outer side of the ganglion and forms a plexus along the vertebral artery.

The Cardiac Nerves.

The cardiac branches from the cervical sympathetic are three on each side, superior, middle and inferior. Proceeding from their respective ganglia they descend into the thorax and form the cardiac plexus, the first of the prævertebral plexuses.

The cardiac plexus consists of two portions, a superficial, or the lesser cardiac plexus and a deep, or the greater cardiac plexus.

The superficial portion is found on the ductus arteriosus, is quite small and often contains a ganglion. It is formed by the superior cardiac nerve of the left side and by the cardiac branch of the pneumogastric. The deep portion, very much larger than the superficial, is situated in the bifurcation of the trachea and is formed by the three cardiac nerves of the right side and the middle and inferior cardiac nerves of the left side with the cardiac branches of the right pneumogastric. From these two portions, which are connected by a communicating branch, filaments de-

scend to the heart along the anterior coronary artery, the anterior coronary plexus, and along the posterior coronary artery, the posterior coronary plexus.

Thoracic or Dorsal Sympathetic.

The dorsal portion of the sympathetic consists of twelve ganglia on each side connected by ascending and descending branches with contiguous ganglia. Each ganglion lies on the front of the head of a rib, and besides its ascending and descending branches of communication is connected with a neighboring spinal nerve.

The internal branches of the dorsal ganglia have the following distribution: Those from the upper five ganglia (about) are furnished to the aorta and the œsophagus, giving a few filaments to the lungs and heart. The internal branches from the lower seven descend to the abdomen, as they are not needed in the thorax, forming as they do so what are known as the splanchnic nerves, whose formation and destination are as follows: the internal branches from the sixth, seventh, eighth and ninth and a part of those from the tenth dorsal ganglia unite successively to form a large cord called the greater splanchnic nerve, wnich pierces the crus of the diaphragm and terminates in a ganglionic body called the semilunar ganglion. The two semilunar ganglia, right and left, surround the cœliac axis and give off an immense number of branches, which, radiating like rays of the sun, constitute the solar plexus. The internal branches of the eleventh dorsal ganglion and part of that of the tenth unite to form the lesser splanchnic which descends to pierce the diaphragm and terminate in the semilunar ganglion of that side. The internal branches of the twelfth dorsal ganglion, usually aided by a branch from the lesser splanchnic, form the least splanchnic nerve which proceeds to the kidney. The branches of distribution of the semilunar ganglia forming the solar plexus are intended to supply the abdominal viscera and walls. The nerves proceed along the artery to any viscus and are known as plexuses which bear the name of the artery they accompany. The plexuses are accordingly as many as the arteries to the abdomen.

1st. The phrenic plexus accompanies the phrenic artery to the diaphragm.

2d. The gastric plexus, accompanying the various gastric arteries to the stomach.

3d. The hepatic plexus, accompanying the hepatic artery to the liver.

4th. The splenic plexus accompanying the splenic artery to the spleen.

5th. The supra-renal plexus, accompanying the supra-renal artery to the supra-renal gland.

6th. The renal plexus, accompanying the renal artery to the kidney.

7th. The superior mesenteric plexus, accompanying the superior mesenteric artery to the small intestine.

8th. The spermatic plexus, accompanying the spermatic artery to the testes.

9th. The inferior mesenteric plexus, accompanying the inferior mesenteric artery to the large intestine.

10th. The aortic plexus, which descends along the aorta and after producing by most of its bulk the inferior mesenteric plexus continues into the pelvis to aid in forming a prævertebral plexus on the front of the sacrum known as the hypogastric.

The renal and supra-renal plexuses are remarkable for the large size and number of their nerves, the kidney receiving some fifteen large filaments.

The Lumbar Sympathetic.

The lumbar portion of the sympathetic system is continuous above with the dorsal by means of branches which pass beneath the ligamentum arcuatum externum, inferiorly its descending branches communicate with the sacral portion. Besides the ascending and descending branches each ganglion, of which there are four or five found lying along the inner edge of the psoas magnus muscle, has external branches to a lumbar spinal nerve. Of the internal branches the upper pass to the aortic plexus and the lower descend to the front of the promontory of the sacrum where they join the hypograstric plexus which is distributed to the pelvic viscera by plexuses accompanying the branches of the internal iliac artery.

Sacral Sympathetic.

The sacral portion of the spmpathetic consists of four or five ganglia with the usual communicating branches and with branches of distribution to aid the hypograstric plexus in supplying the pelvic viscera. These ganglia lie on the front of the lateral aspect of the sacrum near the anterior sacral foramina, the ganglia of each side approaching below until the last pair, meeting in the middle line, fuse into one called the ganglion imprar.

The Cranial Sympathetic.

The cranial portion of the sympathetic consists of four ganglia, lying in and around the skull, with their branches of communication and distribution, and of the carotid and cavernous plexuses formed by the ascending branches of the superior cervical ganglion. Each cranial ganglion is connected with two cranial nerves or two branches of the same nerve, receiving from one a motor and from the other a sensitive branch, and is also connected with the rest of the sympathetic system by a communicating branch. These various communicating branches form the roots of the ganglion. The four cranial ganglia are the ophthalmic, the spheno-palatine, the otic and the submaxillary.

Ophthalmic Ganglion.

The ophthalmic or lenticular ganglion is found in the orbit lying on the outer side of the optic nerve close to the optic foramen.

Its sensitive root is furnished by the nasal nerve; its motor root by the branch of the third nerve sent to the inferior oblique muscle; its sympathetic root by the cavernous plexus.

Its branches of distribution, known as ciliary, five or six in number, pierce the sclerotic coat around the optic nerve and ramifying between the tunics of the eye-ball terminate in the iris.

Spheno-Palatine Ganglion.

The spheno-palatine, or Meckel's ganglion, is the largest of the cranial ganglia and is found lying in the spheno-maxillary fossa just beneath the superior maxillary division of the fifth nerve.

Its sensitive root consists of two filaments from the superior maxillary nerve: its motor root is derived from the facial nerve; its sympathetic root is from the carotid plexus. The last two roots reach the ganglion together, *i. e.*, they are in the same sheath and form apparently one nerve; but the motor root, coming from the vidian, separates from the other branch of that nerve at the termination of the vidian canal, the other branch, the great superficial petrosal nerve, going to the facial through the hiatus Fallopii. The branches of distribution of this ganglion are four, palatine pharyngeal, superior nasal and naso-palatine.

1st. The three palatine branches, anterior, middle and posterior, descend to supply the roof of the mouth, soft palate and tonsils. The

anterior descends through the posterior palatine foramen and gives off branches which pass forward. One of these (the inferior nasal) enters the nasal fossa and is distributed to the mucous membrane of the inferior and middle meatuses.

2d. The pharyngeal branch passes backward through the pterygo-palatine canal to be distributed to the mucous membrane of the pharynx.

3d. The superior nasal are four or five branches which enter the nose through the spheno-palatine foramen and are distributed to the superior meatus of the nose.

4th. Naso-palatine enters the nose through the spheno-palatine foramen, runs inward to the septum and, after giving branches to it, enters the palate through the naso-palatine canal.

Otic Ganglion.

The otic, or Arnold's ganglion, small and oval-shaped, is situated on the inner side of the inferior maxillary branch of the fifth nerve, just after its exit through the foramen ovale. Its sensitive root comes from the auriculo-temporal branch of the inferior maxillary; its motor root from the nerve to the pterygoideus internus; its sympathetic root from the plexus on the middle meningeal artery. Its branches of distribution are three, as follows:

1st. A branch which passes backward to the tensor tympani muscle.

2d. A branch which passes forward to the tensor palati muscle.

3d. The nervus petrosus superficialis minor, which first enters the cranium through a canal between the foramen ovale and foramen spinosum and passing backward enters the tympanum, to join the tympanic plexus, through a canal near the base of the petrous bone. It gives off a branch (nerve of Longet) which enters the hiatus Fallopii to join the intumescentia gangliformis of the facial nerve.

The Outlet of the Pelvis.

The outlet of the pelvis, which in the recent subject, is closed by various soft parts, in the skeleton is seen to be surrounded by the following parts: in front it is limited by the pubic arch, behind by the tip of the coccyx, on each side, about the centre, by the tuberosity of the ischium and running forward from this the rami of the ischium and pubes and backward from it the greater sacro-sciatic ligament or, in the recent subject, the lower border of the gluteus maximus muscle. In the recent

subject the outlet of the pelvis is divided into two portions by a transverse line passing between the anterior edges of the two tuberosities of the ischia, or, in other words, from the indefinite point on one side where the ramus and tuberosity of the ischium meet to a similar point on the opposite side. The portion lying in front of this line is called the perineum and that lying behind it the ischio-rectal region.

Ischio-Rectal Region.

The ischio-rectal region is bounded in front by the transverse line, behind by the apex of the coccyx, laterally by the great sacro-sciatic ligament or the lower edge of the gluteus maximus muscle and the tuberosity of the ischium. It contains three parts to be examined, the anal orifice with its sphincter muscle and, on each side of this, a subdivision known as the ischio-rectal fossa.

Anus.

The anus is the termination of the rectum, and is kept habitually closed by the tonic contraction of muscles called sphincters internal and external. The sphincter ani internus was described with the structure of the rectum, it being a muscular ring around the gut formed by an aggregation of its circular muscular fibres about an inch above the anal orifice. Surrounding the anal orifice, which is seen in the centre of the ischio rectal region, is a thin elliptical muscle called the sphincter ani externus. It arises from and around the tip of the coccyx and passes forward just beneath and closely adherent to the skin to surround the anal orifice, and be inserted in front of it into a point in the centre of the perineal line called the central point of the perineum.

Ischio-Rectal Fossa.

The ischio-rectal fossa is the triangular or wedge-shaped space lying beside the anus, one on each side. It is about two inches deep, the base being at the surface and its limits being indicated by the anus within, the tuberosity of the ischium without, the transverse line in front and the lower edge of the gluteus maximus muscle behind. The apex is above, and is formed by the coming together of two sides of the space, the inner side being a muscle, called levator ani, which is inserted into the side of the lower part of the rectum, while the outer side is the obturator internus muscle. The levator ani muscle is thin and flat and has a most pecu-

liar origin, to understand which some preliminary remarks are necessary. The transversalis fascia, which lies between the transversalis abdominis muscle and the parietal layer of the peritoneum, when it reaches the iliac fossa, where it covers the iliacus internus muscle, takes the name of iliac fascia, which, in turn, when it reaches the brim of the pelvis, assumes the name of pelvic fascia, and this descending into the pelvis when it reaches the commencement of the obturator foramen, divides into two layers, one of which, the external, passes over the inner face of the obturator internus, as the obturator fascia; while the other passes to the base of the bladder and the side of the rectum as the recto-vesical fascia. Now just in the interval left by the splitting of the pelvic fascia the levator ani rises, having internal to it the recto-vesical fascia and external, with a widening interval between them, the obturator fascia. Besides this origin from the fascia, it arises posteriorly from the spine of the ischium and anteriorly from the back of the pubes. The ischio-rectal region thus described is found filled with adipose tissue, the absorption of which, in long-continued, debilitating disease, is the cause of the sunken appearance seen there.

Perineum—In the Male.

The perineum is that sub-division of the outlet of the pelvis which lies in front of the transverse line. Its limits are as follows: In front the pubic arch, behind the transverse line, on each side the rami of the pubes and ischium. Crossing along its centre from behind forward, and continued on to the scrotum, is a ridge of the integument called the raphe.

Upon careful dissection the perineum is found to be formed of the following constituents from the surface upward, viz:

1st. Integument.

2d. Several layers of superficial fascia which in no wise differ from the general superficial fascia found beneath the integument everywhere.

3d. A layer of fascia called the superficial *perineal* fascia, since it is peculiar to the perineum, being attached to the rami of ischium and pubes on each side, in front continuous with the dartos of the scrotum and behind attached to nothing but terminating by changing its name, at the transverse line making a bend on itself and running back toward the pubic arch under tne name of deep perineal fascia. It is separated from the superficial perineal fascia by the root of the penis and the muscles connected with it.

4th. Removing the superficial perineal fascia there are exposed the

root of the penis and its muscles. The root of the penis consists of the two crura attached, one on each side, to the rami of the pubes and ischium, and of the bulb of the corpus spongiosum, which lies between these.

The muscles which are exposed are three pairs—

1st. Transversus perinei, which arises on each side from the spot where the ramus of the ischium is continued into the tuberosity, and passes transversely inward to meet its fellow in the centre. The point where the two perinei are inserted into each other is called the perineal centre. It should be observed that the course of these muscles corresponds with the transverse line.

2d. Accelerator urinæ. This muscle arises from the perineal centre and from the raphe between it and its fellow. The greater portion of its fibres surround the corpus spongiosum to meet the opposing muscle on the top of the corpus, but some of the fibres, posteriorly, are inserted into the deep perineal fascia and ramus of the pubes, while some in front are lost in the corpus cavernosum. Its chief action is to drive the urine forward by contracting on the corpus spongiosum, in which is the urethra.

3d. Erector penis arises from the rami of the ischium and pubes, and passing forward is lost on the upper aspect of the corpus cavernosum.

After removing these muscles and the root of the penis the deep perineal fascia is displayed. This, as stated, is continuous at the transverse line with the superficial perineal fascia, the line of reflection being around the posterior aspect of the transverse perineal muscles. From this point it passes forward to the arch of the pubes, attached on either side to the rami of the ischium and pubes. Just below the arch of the pubes it presents a small, round opening for the passage of the urethra. When the deep perineal fascia is dissected it is found to consist of two layers, called the superficial and deep layers of the deep perineal fascia, which is sometimes called the triangular ligament of the pubes. Between the two layers are found blood vessels and nerves and a pair of muscles called compressors urethræ. The compressor urethræ arises from the point of union between the rami of the pubes and ischium and running transversely inward divides into two fasciculi, which meet those of the opposite side and surround the urethra.

INGUINAL HERNIA.

Inguinal hernia is the protrusion of some portion of the abdominal contents through the abdominal wall, making its way along the inguinal canal. The parts concerned are the lower fibres of the broad muscles of the abdomen, their superficial and deep coverings, and the structures composing the scrotum.

There is no deep fascia investing the broad muscles of the abdomen. When the integument is removed, two layers of superficial fascia are seen, separated from each other by the superficial blood vessels and nerves, the deeper of the two being the stronger. The removal of the deep layer exposes the lower portion of the aponeurosis of the external oblique muscle, known as Poupart's ligament, which extends from the anterior superior spinous process of the ilium to the spine of the pubes, the inner portion forming the outer, or lower, pillar of the external, or superficial, abdominal ring. Poupart's ligament is folded upon itself, backward and upward, forming a groove, directed upward and inward. To its posterior face is attached the transversalis fascia, where it becomes continuous with the iliac, while its anterior face is continuous with the fascia lata and has adherent to it the deep layer of the superficial fascia. Before reaching the spine of the pubes, Poupart's ligament sends downward and backward a mass of fibres, with its base outward and apex inward, to be attached to the spine and pectineal line of the pubes, under the name of Gimbernat's ligament. Turning down Poupart's ligament we expose the combined origin of the internal oblique and transversalis muscles, which arches upward and inward, muscular, to form the conjoined arch, becomes tendinous and arches downward and inward as the conjoined tendon, which is inserted into the crest and pectineal line of the pubes behind the superficial abdominal ring. The outer abutment of this arch is at the middle of Poupart's ligament, the inner one-half inch external to the spine of the pubes, while the centre of the arch is one-half inch above Poupart's ligament. Cutting away these structures we come to the transversalis fascia, behind which is the parietal layer of the peritoneum, the two being separated by some loose connective tissue and fat. In the transversalis fascia is a second opening, called the deep or internal abdominal ring. At the lower, inner, part of the aponeurosis of the ex-

ternal oblique muscle there is a triangular opening, caused by the divergence of the fibres of the aponeurosis, known as the superficial or external abdominal ring; the apex of the opening being directed upward and outward, its base downward and inward and corresponding to the crest of the pubes. The lateral boundaries of this ring are known as its pillars—internal, or superior, attached to the front of the symphysis pubis, external, or inferior, attached to the spine of the pubes. The latter is simply the inner portion of Poupart's ligament. Around the margins of this ring the deep layer of the superficial fascia is attached, forming what is called the inter-columnar fascia. The two layers become continuous below with the dartos of the scrotum. The apex of the triangle is obscured by a few fibres which cross the others at right angles and prevent a further divergence of the fibres and consequent widening of the triangle. These are called the inter-columnar fibres.

About one and one-half inches above and external to this opening, nearly opposite the centre of Poupart's ligament, there is a hole in the transversalis fascia called the deep or internal abdominal ring, situated a little less than one-half an inch above Poupart's ligament and internal to the outer abutment of the arch. Externally this ring is bounded by the conjoined arch, internally by the deep epigastric artery, below by Poupart's ligament. The ring does not exist in a healthy subject. Through this ring the testicle descends in the foetus, and to its margins is attached a prolongation of the transversalis fascia, the infundibuliform tube of fascia, which forms one of the coats of a hernia. Extending between the two rings there is a canal, about one and one-half inches long, the inguinal or spermatic canal, which, in health, transmits the spermatic cord, in the male, or the round ligament, in the female, while, pathologically, it transmits the gut in a hernia.

The spermatic canal is limited internally by the superficial abdominal, externally by the deep, abdominal ring, and its walls are formed as follows: Below by the grooved upper surface of Poupart's ligament; above by the conjoined arch; in front by the aponeurosis of the external oblique; behind, by the transversalis fascia and parietal layer of peritoneum throughout its extent, while, for about its inner half, the conjoined tendon lies in front of those structures. The canal contains the neck of the infundibuliform tube of fascia, arteries, nerves, lymphatics and the duct from the testicle.

On the visceral face of the peritoneum there may sometimes be seen a dimple which corresponds to the deep abdominal ring, and, internal to this, a ridge which is formed by the deep epigastric artery. The space

between the ridge and the mid line of the body is called the internal inguinal fossa, that external to the ridge, the external inguinal fossa.

The testicles, in their descent, enter at the deep ring, pass through the inguinal canal and make their exit at the superficial ring. The cause of this descent is not accurately known, but it is aided by the gubernaculum testis, a mass of unstriated muscular fibres, attached by one extremity to the testicle and by the other to the margins of the superficial abdominal ring. In its descent the testicle carries with it the structures closing the two abdominal rings. Thus, it presses upon the peritoneum at the deep abdominal ring, invaginates it and forces along a process of this membrane which becomes the deepest layer investing the testicle and is known as the tunica vaginalis; next it forces along a process of the transversalis fascia, which, after the descent of the testicle, becomes attached to the deep ring forming the infundibuliform tube of fascia; then, while passing beneath the conjoined arch, muscular fibres, arranged in loops around the cord, are contributed forming the cremaster muscle, which is attached internally to the sheath of the rectus and externally to Poupart's ligament. These loops are attached to each other by fascia called the cremasteric fascia. Lastly, the testicle carries with it a process of the intercolumnar fascia, forming the external covering of the cord, which is, of course, covered by the superficial fascia and integument. Shortly after birth the tunica vaginalis is obliterated from the internal ring to within a short distance of the testicle.

When, from weakening of the abdominal wall, or other cause, an inguinal hernia is produced, it usually follows the course of the testicle in its descent, and, hence, its coverings would be similar to those of the testicle. This form is known as an oblique inguinal hernia, subdivided into complete, when it escapes from the superficial abdominal ring, and incomplete, or bubonocele, when it remains in the inguinal canal. A complete inguinal hernia pushes before it the peritoneum closing the deep abdominal ring, which forms the hernial sac, enters the inguinal canal, receiving an investment from the infundibulum tube of fascia and the cremaster muscle, passes through the superficial abdominal ring, carrying with it a covering furnished by the intercolumnar fascia, descends in front of the cord into the scrotum and is invested by the superficial fascia and the integument. In incomplete hernia the coverings cease at the superficial abdominal ring.

When the peritoneal pouch is not obliterated, there is a direct communication between the abdominal and scrotal cavities, and the peritoneal covering of the hernia is the tunica vaginalis. This form of hernia constitutes what is known as congenital hernia.

In infantile hernia the pouch is closed at the deep abdominal ring only, and the gut descends behind the tunica vaginalis, having three peritoneal layers in front, viz: the two layers of the tunica vaginalis and one layer of the proper investing sac of the hernia.

In the encysted form the gut, carrying its own sac, projects into the tunica vaginalis, leaving in front of it but two serous layers, viz: one of its own sac and one from the tunica vaginalis.

DIRECT INGUINAL HERNIA.—Hesselbach's triangle is bounded externally by the deep epigastric artery, internally by the rectus abdominis, below by Poupart's ligament. It is crossed by the conjoined tendon of internal oblique and transversalis muscles. Hernia may occur either external to or through this tendon. When the hernia is external to the tendon it follows a part of the inguinal canal and has the same coverings as an oblique inguinal hernia, except that the infundibuliform tube is replaced by another prolongation of the transversalis fascia. When through the tendon the latter is pushed before the gut, which has the same coverings as in the oblique form, except that the infundibuliform tube is replaced by another portion of the transversalis fascia, and the conjoined tendon replaces the cremaster muscle. Occasionally the hernia may split the tendon instead of pushing it before it.

FEMORAL HERNIA.

DEFINITION.—The protrusion of an abdominal viscus through the femoral or crural ring.

PARTS CONCERNED.—Behind the femoral arch is found the upper border of the pubic bone, marked, from within outward, by the angle, crest, spine, pectineal line, triangle and eminence and the psoas groove. Stretching from the anterior superior spinous process of the ilium to the pubic spine and pectineal line, is Poupart's ligament, forming the femoral or crural arch. Gimbernat's ligament is the portion of Poupart's ligament which is inserted into the pectineal line. The other structures concerned are the iliac artery and vein and their sheath, the peritoneum and fascia closing the mouth of the ring, the fascia lata, cribriform and superficial fasciæ and the integument.

The space between Poupart's ligament and the upper border of the pubes is filled from without inward by the psoas and iliacus muscles, the anterior crural nerve and the femoral sheath containing the femoral artery and vein and having in it an unoccupied space internal to the vein. This sheath is formed in front by the transversalis, behind by the iliac fascia.

FEMORAL RING.—The femoral ring is the upper opening of the femoral canal. Internally it is bounded by the outer edge of Gimbernat's ligament; externally by a septum in the sheath separating the open space from the femoral vein; above is Poupart's ligament; below, the upper border of the pubes and the origin of the pectineus muscle. The femoral canal extends downward in the sheath for about one inch and is lined by a prolongation of fascia which covers the vessels and is known as the fascia propria. The canal terminates by the contraction of the sheath so as to closely hug the vessels. The femoral ring is closed above by the peritoneum and a thin layer of fascia called septum crurale, or femorale, which usually has lying upon it a lymphatic gland.

BLOOD VESSELS.—Just beneath Poupart's ligament the external iliac vessels terminate by becoming the femoral; but, before its termination, the external iliac artery gives off a large branch called the deep epigastric, which lies above and external to the femoral ring and between it and the deep abdominal ring. The external iliac vein lies to the outer

side of the ring, so that in all cases there are blood vessels above and external to the ring. The deep epigastric artery sometimes gives off a branch called the obturator, which may descend next the iliac vein and on the outer side of the ring; but it sometimes passes inward and downward, arching above and internal to the femoral ring, which is thus surrounded by blood vessels on all sides except below. The epigastric also gives off a small pubic branch which lies above the ring, but is, from its size, unimportant.

FASCIA LATA.—The investing fascia of the thigh, or fascia lata, presents, about one inch below Poupart's ligament, an oval opening called the saphenous opening. The opening is closed in the recent state. It runs obliquely downward and outward, is about one inch in its vertical by three-quarters of an inch in its transverse diameter; its inner edge is straight and prolonged outward behind the outer edge; its outer is curved, runs downward and outward from Gimbernat's ligament to the inferior cornu and is called Hey's ligament or the falciform process of Burns. The external part of the fascia is known as the iliac portion and is attached to the crest of the ilium and the outer portion of Poupart's ligament, sending inward a spur which is attached to the pectineal line, runs over the femoral vessels and forms the outer boundary of the saphenous opening. The inner part, called the pubic portion, is thin and weak, is attached to the ischio-pubic ramus and is prolonged beneath the femoral vessels. The saphenous opening is covered by the skin and two layers of superficial fascia, of which the deep, under the name of cribriform fascia, becomes adherent to the margins of the opening. The cribriform fascia is attached more firmly below than above, and hence tends to direct a protruding gut upward.

COURSE.—A femoral hernia passes downward through the femoral ring, thence down the canal as far as the saphenous opening, turns forward through this opening and then runs upward on the front of the thigh. The main causes of the ascent are the firmer attachment of the cribriform fascia below, the narrowing of the femoral canal and the movements of the thigh.

COVERINGS.—Femoral hernia pushes before it, first the parietal layer of peritoneum and fat covering the femoral ring, then the septum femorale, fascia propria, cribriform fascia, superficial layer of the superficial fascia and, lastly, the skin.

ORGANS OF GENERATION IN THE FEMALE.

The organs of generation in the female are divided into those within and those external to the pelvic cavity. The external organs, vulva, clitoris, &c., occupy the perineal space. The boundaries of the outlet of the pelvis are the same in both male and female subjects, but the ischio-rectal region is wider and longer in the female. In the mid-line are seen the opening of the vagina and the anus, separated by a mass of tissue about one inch thick called the perineal body. The external organs consist of two labia majora, surrounding the aperture of the vagina, composed externally of skin, which is covered with hairs and internally of mucous membrane, and united both in front and behind. Internal to these are two thinner projecting folds, one on each side, called labia minora, which enclose in front a projecting body, the clitoris. Between the clitoris and the mouth of the vagina is a space about one inch long called the vestibule, at the hinder part of which, near the mouth of the vagina, is an opening, the meatus urinarius.

The pelvic organs consist of an egg-producing body—the ovary—and a channel to convey the egg to the exterior. This channel is modified to perform the function of hatching—the uterus—and that of copulation—the vagina. The uterus consists of an upper part or fundus, a middle portion or body, and a lower part or neck. The vagina is a short, bent canal which serves the double function of conveying the semen to the uterus and of conducting the fœtus to the external world. The relations which the uterus and its so-called appendages bear to neighboring structures constitutes the remainder of the study of the female generative organs.

The peritoneum passes over the brim of the pelvis, enveloping the first portion of the rectum completely, and covering the upper one inch of the second portion in front, as in the male. From the front of the rectum it passes to the posterior wall of the vagina, which it covers for its upper one inch or inch and a half; passes to the back of the uterus and mounts upon it to its top, where it spreads out upon either side to envelop the appendages of the uterus; descends upon the front of the uterus, covering all of the front except that part contained within the vagina, and thence passes to the bladder, which is covered, as in the male, for its posterior half, the peritoneum leaping from the top of the

bladder to the posterior surface of the anterior abdominal wall, forming the false ligaments of the bladder as in the male. That fold of peritoneum which extends transversely outward from the top of the uterus, envelops the appendages of that organ in a double-layered fold which forms a vertical septum extending transversely across the pelvic cavity, striking the lateral pelvic walls a little behind their middle, is known as the broad ligament of the uterus. The folds of peritoneum between the uterus and vagina and rectum posteriorly and the uterus and bladder anteriorly are known as the posterior and anterior ligaments of the uterus respectively, divided by the mid-line into two anterior and two posterior. Another ligament, a round cord, extends, in the folds of the broad ligament, from the lateral aspect of the uterus to the internal abdominal ring, to follow the inguinal canal and be finally lost in the labium majus, under the name of the round ligament. The depression between the vagina and uterus in front and the rectum behind is known as the pouch of Douglas, the posterior ligaments bounding it on either side.

The broad ligament encloses between its folds the fallopian tube, ligament of the ovary, round ligament and ovary. The fallopian tubes occupy the highest part of the broad ligament, extending outward from the upper angle of the uterus to become closely connected with the ovary. They enlarge as they pass outward and form at the extremity a trumpet-shaped mouth, fringed by diverging processes or fimbriæ, one of which is attached to the ovary. The tube is tortuous through the greater part of its course and when stretched out is about five inches long. A little behind and below the fallopian tube is a small round cord, the ligament of the ovary, which attaches the ovary to the upper part of the side of the uterus.

The ovary is about one and a half inches long, one inch wide and half an inch thick. One end looks toward the uterus, one end outward, one surface upward and forward, the other downward and backward. It is completely invested by peritoneum, bulging the posterior fold of the broad ligament and appearing not to be in contact with the anterior fold. It is held to the uterus by its ligament and the ova formed by it are conducted to the uterus by the fallopian tube.

The lower end of the uterus projects into the vagina, which thus surrounds the neck of the uterus, cutting off the lower portion of that organ from relation with surrounding viscera. The vagina extends higher up on the uterus posteriorly than anteriorly.

The rectum is about the same length as in the male, and is divided into three portions for study. Its lateral and posterior relations are the same

as in the male, while the anterior relations are different. The first part of the rectum has in front of it the uterus, separated from it by convolutions of the small intestine. The upper inch of the second portion, that part covered by peritoneum in front, is separated, by convolutions of the small intestine, from the posterior wall of the vagina, which in turn cuts off the neck of the uterus. The remainder of the second portion is adherent to the posterior wall of the vagina. The third part of the rectum passes downward and backward, diverging from the vagina, the interval between the two being filled by a triangular mass of connective tissue forming the perineal body and corresponding to the tissue between the bulb of the corpus spongiosum and the rectum in the male. The ureter bears the same relation to the rectum as in the male, and lies upon the side of the vagina which cuts it off from relation with the neck of the uterus.

The female bladder occupies the same position as in the male, lying behind the symphysis pubis and bearing the same relation to the peritoneum. The anterior and lateral relations are also the same, except that there is no vas deferens, the position of this structure being in part occupied by the round ligament, which lies above and internal to the external iliac artery. The posterior surface of the bladder is separated from the anterior wall of the uterus by some convolutions of the small intestine. The base of the bladder looks more nearly downward than in the male and rests for its anterior three-fourths upon the anterior wall of the vagina, to which it is firmly adherent, its posterior one-fourth being covered by peritoneum. The urethra is nearly straight, but has a slight upward concavity. It lies on the anterior wall of the vagina, is about two inches long, runs through an opening in the triangular ligament about one inch below the symphysis pubis, is surrounded by muscular fibres forming what is called the compressor urethræ, and terminates in the vestibule at the meatus urinarius.

The vagina is the canal of communication between the uterus and the vulva. It is directed obliquely downward and forward, corresponding to the axis of the outlet of the pelvis, while the uterus corresponds to the axis of the brim, the two thus forming a curve whose concavity is forward. It is compressed, so that its anterior and posterior walls are in contact. Its anterior wall is about two and a half inches in length, its posterior about three and a half. It is partly closed in the virgin by the hymen. The relations of the vagina have been given in connection with other structures.

THE AXILLA.

The space known by this name lies between the chest wall internally, the humerus externally and the muscles in front and behind. In the skeleton only the apex of the space is complete, being bounded in front by the clavicle, behind by the upper border of the scapula, internally by the first rib. Below the apex the space corresponds to the upper five ribs internally, the scapula behind and the bottom of the bicipital groove externally. In the recent subject the space has the shape of a three-sided pyramid. The apex is above, the base below and the sharp angle external at the bicipital groove. The whole space is closed in by soft structures. The anterior wall is furnished by the pectoralis major, which covers the whole of the space, while beneath this, forming only the middle of the anterior wall, is the pectoralis minor. The posterior wall is formed by three muscles, subscapularis, teres major and latissimus dorsi; but the order in which they come changes in different parts of the space. Near the inner wall the order, from above downward, is subscapularis, teres major, latissimus dorsi; but near the external wall, owing to the fact that the tendon of the latissimus dorsi winds around the teres major and is inserted above it, the order is subscapularis, latissimus dorsi, teres major. The inner wall is formed by the upper six serrations of the serratus magnus muscle and the intercostal muscles corresponding to the upper five intercostal spaces. The lower border of the muscles which enter into the anterior and posterior boundaries of the axilla form the anterior and posterior axillary folds, of which the posterior is the thicker and more prominent. Stretching across from one fold to the other, and continuous with the investing fascia of the arm, is a strong fascia which forms the floor of the space. The contents of this space are the brachial plexus of nerves and its terminal branches, the axillary artery and vein and their branches, lymphatic glands and a quantity of areolar tissue and fat.

INDEX.

N.

NERVES, OR NERVE (*Continued*):

S.